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Prospects for economic growth and poverty reduction in Uganda
a Computable General Equilibrium (CGE) analysis

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University of Dundee

PROSPECTS FOR ECONOMIC GROWTH AND POVERTY REDUCTION IN UGANDA: A COMPUTABLE GENERAL EQUILIBRIUM (CGE) ANALYSIS

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Table of Contents

List of Tables

List of Figures

Dedication

This thesis is dedicated with affection to my mother, Valeria Bwongeriize who taught me the virtues of patience, hard work, perseverance, and the importance of education. Her love, guidance, and dedication to me have always been my source of strength and inspiration.

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To all those who supported me in one way or the other and I have not mentioned your names, I would like to express my sincere gratitude to you all.

Declaration

I declare that I am the author of this thesis and that the substance of this thesis has not been previously submitted for a higher degree. To the best of my knowledge and belief, this thesis contains no material previously published or written by another person except where due reference is made in the thesis itself.

Signed

Drake F. Kyalimpa, Ph.D. Candidate

Date: 26/01/2014

Certification

This is to certify that Mr. Drake Kyalimpa conducted his research under my supervision in the Department of Economic Studies, University of Dundee. Mr. Drake Kyalimpa has fulfilled all the conditions of the relevant Ordinances and Regulations of the University of Dundee for obtaining the Degree of Doctor of Philosophy.

Signed………………….

Professor Hassan Molana

(Supervisor)

Date: …………………………

Abstract

Uganda faces considerable challenges in revamping economic growth performance, reducing the proportional of people living below the poverty line to below 20 percent, and attaining other Millennium Development Goals by the year 2015. These developments have prompted the government to prioritise poverty alleviation and the attainment of sustainable real GDP growth (i.e. at 7 percent per annum), among other policies. This dissertation argues that a proper identification of the critical sectors of growth with significant linkages to the rest of the economy can guide policy makers to affect the outcomes of external shocks (e.g. by redirecting resources to sectors with potential for higher output growth and welfare effects).

Using the 2002 Social Accounting Matrix (SAM) for Uganda, we investigate the properties of the multipliers that can be calculated from the SAM, in particular contrasting them with the simpler input-output multipliers. Using the SAM multipliers, the computed linkages suggest that Agriculture, Food Processing, and Other Services (Trade, and Health and Education) are the key sectors of Uganda's economy. Similarly, Manufacturing, Construction, and Transport were found to be sectors with weak linkages to the rest of the economy. Moreover, the multiplier impact on output, employment, and household income distribution is higher with in agriculture relative to other sectors. Our multiplier results confirm the need for policy makers in Uganda to target agriculture-led growth if Uganda is to substantially raise economy wide growth, and to improve household incomes for significant poverty alleviation. Policies to boost the agriculture sector include: building and maintaining feeder roads, provision of farm inputs, training farmers on better methods of production and productivity, reviving cooperatives (i.e. to enable coordinated farming activities, storage, processing, and marketing of farmers produce, and easy access to credit from lending institutions). It should be noted that Agriculture in Uganda is

characterised by low productivity resulting from the use of poor inputs, undeveloped value chains, and low public and private investment in the sector.

Government should significantly invest in agro-processing industries to increase value addition and exports for higher incomes. Since such investments are costly, requiring significant capital investments which majority of poor farmers cannot afford, the government should promote public-private sector partnership. It should be noted that Uganda's exports are dominated by unprocessed primary low products which fetch low earnings from world markets.

Using a country specific CGE model and selected exogenous changes and policies, our findings suggest that an increase in the world price of exports and workers remittances, and a decrease in import tariffs are growth and welfare enhancing with the positive shock to world export prices producing the largest impact on real GDP, employment (largely, low skilled labour and in agriculture), factor and household incomes. The significant role of migrant remittances in growth and poverty alleviation (i.e. by increasing household incomes, and investment in agriculture, education, and real estate among others) is worth noting. These findings suggest that Ugandan authorities could encourage Ugandans living and working abroad to invest at home by introducing a diaspora bond and sharing information on investment opportunities to encourage increased inflow of workers remittances which would boost domestic investment. Where possible, surplus labour could be exported to other regions or countries and arrangements made to have workers remittances invested in Uganda.

In all the policy experiments performed, we find that the welfare of households in the northern and eastern regions of the country is lower compared to that of households based in other regions. This suggests that the government needs to design and implement specific poverty alleviation programs in these regions. The relatively high poverty in northern and eastern regions is attributed to the 19 year civil conflict and the communal land ownership which limits agriculture production for food security and improved household incomes. The government could increase the provision of social and physical infrastructure and promote sustainable agriculture by opening up irrigation schemes, supplying farmers with drought resistant crops, restocking farms, and building and maintain valley dams, and implementing land reforms which promote agriculture.

Given the importance of agriculture to Uganda's growth and poverty alleviation prospects, we argue that the government should implement the recommendations of the Comprehensive African Agriculture Development Program (CAADP) and the Maputo Declaration which calls for the allocation of 10 percent of the national budget to agriculture. This allocation is necessary to achieve the target of agriculture sector growth by 6 percent which is required to reduce significantly the number of Ugandans living in extreme poverty and hunger. The budgetary allocation of 4 percent coupled with inadequate supervision, and corruption and misallocation of funds meant for agriculture development programs have contributed to persistent decline in in output and increase in rural and urban poverty. Our results suggest agriculture is associated with higher employment of low skilled labour which is the largest labour force in Uganda. According to the World Bank, employment is the surest way to poverty alleviation. Thus, Uganda should pursue an agriculture led growth strategy for poverty alleviation and sustained economic growth. However, to substantially increase household incomes and contribute to poverty alleviation, policy interventions in agriculture should focus on increasing value addition through food processing and exports.

Further, interventions that empower women to own assets should be enforced by government. Women are the principal users of land, and they must have stronger rights over the resources they depend upon. Our simulations have demonstrated that employment and incomes of women increase from interventions that target the agriculture sector in Uganda. Women constitute over 90 percent of the total labour force employed in agriculture and earn less or none of farm incomes, and most of them operate under chronic poverty. To gain greater knowledge of and control over their environment and build more productive sustainable systems, the government could empower women with basic education and training, increase their access to new technologies and mobilise them to participate in rural saving banks and cooperatives to boost their earnings from agriculture.

Our results suggest that Services (mainly education and health) are potential candidates for growth and poverty alleviation in Uganda because they generate significant employment. However, Uganda, Services employ high skilled labour and are urban based, implying they cannot absorb the dominant low skilled labour and the youth. According to the Uganda Bureau of Statistics, Uganda currently has about 34.5 million people of which about 65 percent are youth. About 83 percent of these youth (aged 18-30 years) have no formal employment. This calls for authorities in Uganda to reorient the current curriculum towards her development needs where the youth and graduates are trained to be job creators and not job seekers. Massive investment in vocation training where the youth are trained and equipped with skills to manage their own lives by engaging in small scale projects should be prioritised by the government.

To overcome the high rate of youth and graduate unemployment in developing countries Uganda inclusive, the donor community in collaboration with African governments identified vocational training as a critical component in each country’s poverty reduction strategy. To achieve this, students should be trained in fields such as entrepreneurship, agriculture, and building construction. Uganda stands to benefit from the allocation of shillings 426 billion (US$171.5 million) from donors for health, technical and business institutions. A number of new technical institutes are being earmarked for refurbishment and construction in selected parts of the country beginning financial year 2013/2014. The largest share of these funds (about Uganda shillings 104 billion) is from the World Bank. Other donors are Belgium (Uganda shillings 44 billion) and the Islamic Development Bank (Uganda shillings 35 billion).

Finally, the vast majority of the poor in Uganda are rural based smallholder farmers working in conditions of either static or declining productivity. Poverty reduction and broad-based growth in Uganda is clearly dependent on rural development. At present the agricultural growth that is badly needed to lift rural areas out of poverty is not taking place in any systematic way. As pointed out by the International Fund for Agriculture Development, in order to realize the potential of the land and reduce poverty and attain better food security, the rural poor need adequate access to natural resources, and they need assistance in developing their capacity to manage and utilize those resources productively. The Uganda government needs to prioritise interventions in key productive sectors of the economy this study has identified especially in agriculture and services to boost household incomes. Tis will go a long way in reducing income disparities and significantly alleviating poverty especially in rural areas where majority of poor households live.

Chapter 1

Introduction

1.1 Introduction and Background

Uganda is a small open economy in Sub-Saharan Africa and has been long regarded as one of the fastest growing economies on the continent, with a sustained average growth of 6 percent per annum. This growth is largely attributed to substantial economic reforms that were implemented in the early 1990's. These economic reforms were accompanied by remarkable increase in economic growth and reduction in absolute poverty, and were partly boosted by increase in global coffee prices. This enabled Uganda to attain one of the highest per capita real GDP growth rates (2.8 percent) in the world during this period. Given these achievements, the World Bank referred Uganda's efforts as the most far reaching stabilization and structural reform programs in Africa, and one of the most comprehensive reform efforts in the world (World Bank 2007, 4). Even though Uganda attained this per capita growth rate at the low base, it was higher than the 1.7 percent growth rate for most developing economies. The impressive economic growth led to decline in incomer poverty from 56 percent in 1999 to 38 percent in 2002/2003, 31 percent, in 2006, and 23 percent in 2010 (Country Poverty Reduction Strategy Paper, 2010/2011-2014/2015). Despite the impressive macroeconomic performance, poverty remains relatively high in the rural areas where over 80 percent of the households live. It is estimated that rural areas contributed about 93 percent to the national poverty headcount between 2002/2003 and 2005/2006 (Uganda Millennium Development Goals Report, 2007). Uganda's economy heavily relies on agriculture as the main source of employment, household income, and foreign exchange earnings. Agriculture is the major source of raw materials used in the manufacturing sector and contributes about 75 percent of export revenues (Uganda Human Development

Report, 2007). However, inadequate government budgetary allocation to the agriculture sector (i.e. about 4 percent per annum), coupled with volatility of international commodity prices have made it difficult for Uganda to achieve the much required agricultural sector growth of about 6 percent per annum, which would eventually reduce absolute poverty and sustain growth of the economy at 7 percent per annum. In addition, agricultural sectoral growth is required for the attainment of some of the country's Millennium Development Goals (i.e. reducing absolute poverty to below 20 percent by the year 2015).

Further, in the last five decades or so, Uganda's economy experienced varying growth rates. From independence in 1962 up to 1971, gross domestic product grew at an average of 5.2 percent per annum. However, between 1971 and 1979, GDP declined by 25 percent due to political instability and economic mismanagement. From 1971 to 1979, Uganda's economy was seriously affected by economic mismanagement and civil unrest that negatively impacted on the gains made during the previous periods. The rate of inflation averaged 30 percent per annum between 1970 and 1980. This was mainly attributed to financing of government expenditure through bank borrowing. During this period, GDP declined by 1.6 percent per annum, exports fell by 8.5 percent and imports increased by 9.8 percent. The fall in exports led to a decline in export earnings and this culminated into unfavorable balance of payment and external debt positions (Poverty Reduction Strategy Paper, 2010). In addition, the economy grew at 5.5 percent between 1981 and 1983 but recorded negative growth rates in 1984 and 1986 mainly due to high import prices of energy, fall in Agriculture export performance, and macroeconomic instability with double digit inflation.

Between 1987 and 1996, GDP grew at an average of 6.5 percent translating into a 3.4 percent growth in per capita terms. In the mid 1990's the government adopted structural reforms which included privatization of public enterprises, liberalization of the coffee sector and implemented the first Poverty Eradication Action Plan (PEAP, 1997). These reforms led to impressive growth rates with GDP growth averaging 7.2 per cent per annum between 1997/1998 and 2000/2001. Economic growth declined to 6.8 percent between 2000/2001 and 2003/2004, and increased to 8 percent over the period 2004/2005 to 2007/2008. The economy grew at 5.8 percent during 2009/2010. This was, however less by 1.4 percentage points compared to the 7.2 percent GDP growth recorded in 2008/2009 (Bank of Uganda Annual Report, 2009/2010). The decline in economic growth was mainly attributed to adverse domestic and international economic conditions (i.e. high prices of imported crude oil) that resulted into a weaker domestic currency, the decline in foreign remittances; reduced export performance due to drought and diseases, and declining commodity prices particularly of coffee.

During this time, growth was mainly driven by the service and industrial sectors which grew at 8.8 percent and 8.9 percent respectively. The agricultural sector grew at a low rate of 2.1 percent due to unforeseen weather conditions that resulted in negative growth rates for the cash crop sector[1] (-2.9 percent) and a relatively low growth rate in the food crop sector[2] (2.7 percent). The financial services sector grew at 21.1 percent, down from 25.4 percent in 2008/2009. To compound the problem of slower agriculture sector growth, infrastructural deficiencies, and the limited share of the national budget allocated to agriculture (an average of 4 percent per annum), the structure of the economy is biased towards the Service and Manufacturing sectors as the main drivers of growth making it hard to implement agricultural development policies. It can therefore be argued that economic growth is being spearheaded by

[1] Activities involving the growing of crops for export. Such crops include coffee, cotton, tea, and
[2] Activities involving the production of food crops for subsistence consumption, supply of raw materials to processing industries and marketing in the domestic market. Such crops include: maize, bananas, and cereals.

sectors that have weak linkages to the rest of the economy, making it hard for policies to reduce household poverty and to sustain growth.

The decline in agriculture sector growth highlights the challenges the country needs to address to alleviate rural household poverty where the sector is the dominant employer, and source of income majority of households. The importance of the agriculture sector is further reflected by the fact that in 2008/2009, the sector contributed 90 percent of total export earnings, generated 23.7 percent of GDP, and directly or indirectly provided for the livelihoods of about 90 percent of the population (MFPED, 2009). On the other hand, it can be argued that the low performance of the agriculture sector explains why regional poverty and inequality have persisted despite various government policy interventions. Similarly policies and external factors that affect the sector, most notably global price fluctuations, and unpredictable changes in productivity and infrastructural constraints are likely to have significant effects on rural poverty and overall economic growth. Thus, the design of poverty reduction and growth policies must take into account the effects of such shocks. A key research contribution of this dissertation is the identification of critical sectors of growth with significant linkages to the rest of the economy. Such sectors can guide policy makers to affect the outcomes of exogenous changes. If for example, agriculture is Uganda’s key sector and that our simulations suggested that increased investment in agriculture would increase incomes of low skilled labour and rural households, then the appropriate policy would be to increase investment in infrastructure (i.e. feeder roads, provide credit facilities, training and high yield crops to farmers, access to domestic and regional markets, and increase value addition to agriculture output for higher incomes.

Apart from international price fluctuations of primary products, Uganda’s economy is prone to various internal and external shocks. These include: climatic conditions (droughts, floods,) which reduces supply of agriculture output, falling remittances, competition from cheap imports from China, the Middle East, and member states in East African Community and the Common Market for Eastern and Southern Africa). According to the World Bank, migrant remittances significantly contribute to poverty reduction because such transfers are directly received by households to purchase farm inputs, food, housing and scholastic materials, to finance savings, and about 40 percent of these transfers are invested in small scale projects (World Bank Remittance Report, 2010-2011). The report further stresses that Ugandans living abroad remitted about US$773 million (shillings 1.7 trillion) in 2010. This is a remarkable increase from US$694 (shillings 1.56 trillion) that was remitted in 2009. On the other hand, foreign transfers surpassed incomes from top traditional sectors such as tourism, coffee, and fish which earned US$400 million (shillings 900 billion), US$269 (shillings 605 billion), and US$143.53 million (shillings 323 billion) during this period. However, the year 2009 witnessed a 47 percent decline in foreign transfers. To emphasize the importance of migrant remittances, the decline in real GDP growth from 7 percent in 2008/2009 to 6 percent in 2009/2010 was partly attributed to falling remittances (Bank of Uganda Annual Report, 2009/2010). Trade liberalisation and an increase in migrant remittances are two of the selected experiments that will be performed in this study.

Further, the World Bank[3], in its recent poverty assessment stated that despite the impressive growth and reduction in absolute poverty, there has been increasing income inequality in the country and this is particularly high between rural and urban areas. Regionally, the northern and eastern regions have the highest incidence of poverty compared to western and central regions. This has been

[3] There is abundant cross-country evidence on the strong positive relationship between GDP growth and poverty reduction. This relationship applies also to Sub-Saharan Africa (SSA). Demery and Squire (1996), for example, argue that the dominant factor responsible for changes in poverty in SSA during the 1980s is economic growth (World Bank, 2005a).

attributed to the 19 year civil conflict and inadequate infrastructure that have characterized these regions (Millennium Development Goals Country Report, 2007). The poverty assessment further acknowledges that inequality exists between different household groups especially between rural and urban women regarding fertility; and between households due to educational differences.

Although there was a decline in the national Gini coefficient from 0.43 to 0.41 between 2002/2003 and 2005/2006 (Okidi *et al*., 2005), inequality remained high in rural areas compared to urban areas. Regionally, all regions experienced an increase in inequality between 1997 and 2003, the most affected being the central region where the Gini coefficient increased from 0.36 in 1997 to 0.42 in 1999/2000, and 0.46 in 2002/2003. Similarly, inequality continued to increase amidst Uganda's continued growth and poverty reduction nationally. The Gini coefficient was 0.408 in 2006 and increased to 0.428 in 2010. It should be noted that higher inequality tends to retard growth in poor countries. Income inequality diminishes the growth potential through the erosion of social cohesion, increases social unrest and social conflict and results into uncertainty of property rights (Barro, 1999).

Based on the above argument, it is therefore important to identify policies that reduce poverty and inequality. In this dissertation, we use compute various welfare and inequality measures and use these measures to analyze the impact of exogenous changes on welfare. It has also been suggested that for growth to have a lasting impact on poverty alleviation, it must occur in sectors and regions where the poor households live. In other words, the composition of growth matters for poverty alleviation (Loayza and Raddatz, 2009). Unfortunately, available evidence suggests that economic growth in Uganda since 1990s was achieved at the expense of increasing rural poverty and inequality. Studies have shown that even during growth, the distribution of income matters (Thorbecke *et al*., 2000; Ssewanyana, 2009; Okidi *et al*., 2007; and Geda *et al*., 2008). This dissertation is not only concerned with the implications of selected exogenous changes and policies on growth of Uganda's economy, but the welfare implications of these policies on individual households and factors of production (i.e. different labour types).

1.2 Motivation of the Study

Uganda, like many developing countries, has a national development plan that places considerable emphasis on increasing economic growth while reducing poverty (IMF Country Poverty Reduction Strategy, 2010). Agriculture led growth accompanied by growth in food processing and exports are at the core of the country's development strategy. However, available evidence has shown that growth in other sectors is required in order to sustain economic growth. There is little quantitative evidence identifying sectors that can effectively contribute to economy wide growth and income generation in Uganda. This dissertation is intended, among other objectives, to find the possible sources of growth and poverty alleviation in Uganda.

Growth has been generally regarded as the best means of alleviating poverty in developing economies in the long-run. However, the failure of growth focused policy interventions has forced economists and policy makers to rethink this strand and to focus on poverty-focused policies (Hayman, 2003). Recent studies on pro-poor growth suggest that researchers and policy makers alike are looking for a middle ground. Pro-poor growth policies recognize the relationship and potential tradeoff between growth and equity in reducing poverty (Ravallion and Datt, 2002; and Ravallion, 2004). Thus, the emphasis should be on those policies that not only increase economic growth but increase the participation of the poor in the growth process (Thurlow and Wobst, 2004). Even though growth is good for poverty alleviation (Dollar and Kraay 2002; Ravallion and Chen 1997; Fanta and Upadhyay

2009), not all growth is good for the poor. Growth for poverty alleviation is not a sufficient condition. The distribution of income matters (Datt and Ravallion, 1992; Kakwani, 1993; Ravallion and Datt, 1996). Pro-poor growth is concerned with the interrelation of growth, poverty and inequality (McCulloch, Robson, Boulch, 2000; Kakwani and Pernia, 2000; and Kakwani, Prakash and Son, 2000). In addition, understanding the effects of distributional changes associated with economic growth and poverty alleviation is important but this requires the use of micro-macro level data such as the social accounting matrix (Bourguignon, 2002). This dissertation applies a SAM based CGE model to Uganda's economy to analyse the distributional effects of selected exogenous changes and policies.

Further, economic growth in Uganda has not been inclusive. For Growth to contribute to poverty reduction and improve the economic well-being of the society, it must take place in sectors where the majority poor live or participate. Other studies have complemented on this debate of pro-poor growth by suggesting a measure called the poverty equivalent growth rate (Kakwani *et al*., 2004 and Son, 2003). This measure takes into account both the magnitude of growth and how the benefits of growth are distributed to the poor and non-poor. Pro-poor growth can be defined as relative and absolute pro-poor growth (Kakwani *et al*., 2004). The relative concept arises when the benefits of economic growth that goes to the poor are proportionately more than those received by the non-poor. This further implies that when growth reduces poverty, it does also improve relative inequality. Similarly, a measure of pro-poor growth is absolute if the poor receive the absolute benefits of growth equal to or more than the absolute benefits received by the non-poor. This further implies that inequality is expected to decrease during the process of economic growth. Absolute pro-poor growth is the strongest requirement for the achieving pro-poor growth and is thus referred to as super pro-poor (Kakwani *et al*., 2004).

Uganda provides an ideal example for this study. The country is endowed with favourable agricultural conditions and significant mineral resources. These natural resources have provided Uganda with potential sources for growth and poverty alleviation. Between 1990 and 2000, the government embarked on broad based economic growth spearheaded by private sector investment which was mainly concentrated in the service sector and urban areas. Employment in the service sector is dominated by a few, high skilled labour, leaving the majority of low skilled labour unemployed. The high rate of unemployment among the youth and low skilled labour partly explains the high inequality that exists in Uganda despite robust economic growth (Ssewanyana *et al*., 2009, and Okidi *et al*., 2007). In addition, the last two decades have been characterized by lack of significant private sector investment in the agriculture sector. The resulting sectoral and spatial concentration of investment created strong urban-bias at the expense of agriculture and rural development. As a result, low agriculture productivity, rural poverty, and inequality remain Uganda's key challenges that various government interventions have failed to address.

The motivation of this dissertation comes from the fact that despite the broad based economic growth and poverty reduction that Uganda achieved between 1990 and 2010, poverty and inequality has remained relatively high especially in rural areas. This further suggests sectors that experienced significant growth (i.e. services and manufacturing) during this period did not significantly reduce regional poverty and inequality. It is important to note that the significant growth and poverty reduction recorded in the late 1990s with an increasing share of services and industry in value achieved when the value added of services and industrial sectors, and a declining share of agriculture in value added. Note that services and industrial sectors are urban biased and employs only skilled labour leaving the majority of the low skilled labour force unemployed. The questions we ask are: is sectoral growth sufficient for poverty reduction? Did growth occur in sectors with weak linkages to the rest of the economy? Why did growth and poverty reduction occur with increasing inequality? This dissertation seeks to find answers to these questions by identifying Uganda's key sectors for growth and poverty alleviation, and their implications on welfare. These sectors should have significant linkages to the rest of the economy. We argue that such sectors should also significantly contribute to welfare by reducing inequality (i.e. by increasing household incomes through increased factor employment as well as growth) as a result of selected external changes and policies for growth and poverty alleviation. In addition, the World Bank suggests that one of the most important mechanisms to translate growth into poverty reduction is employment (World Bank, 2011). This could be true for Uganda where growth in the service and manufacturing sectors did not significantly increase employment in the agricultural sector. Limited employment in the agriculture sector implies low household incomes and increase in inequality since majority of households live in rural areas and are engaged in agriculture activities. Perhaps, these growth sectors have weak sectoral linkages with the rest of the economy. This dissertation seeks to identify those critical sectors and policies that could drive growth, alleviate poverty while reducing inequality by increasing mass participation in the growth process.

Further, the identified sectors could play a critical role in guiding further policy interventions for growth and poverty alleviation. It is worth mentioning that the main factor in the Poverty Eradication Action Plan (PEAP) is transforming the agricultural sector by raising productivity, value addition through agro-processing industries and increased exports. It has also been suggested that under the Comprehensive African Agricultural Development Program (CAADP), Uganda is on course to attain its first Millennium Development Goal (MDG) of reducing the proportion of those living below the poverty line by 2015. However, this is possible only if the agriculture sector grows at 6 percent per annum between 2010 and 2015 to generate a 6.1 percent real GDP growth. If this growth is sustainable, then, the national poverty head count will decline from 24.3 to 18.9 percent by 2015 (Thurlow *et al*., 2008). Achieving this goal will require the government to allocate about 14.3 percent per year of its total budget allocation to agriculture. However, the authors suggest that such an ambitious goal may not be attainable if government does not make significant investments in agriculture and maintain the efficiency of public spending. Currently, the government allocates about 4 percent of the budget to the agriculture sector (Background to the Budget, 2010/2011). The limited funds allocated to agriculture are mentioned as the primary binding constraint limiting faster poverty alleviation especially in rural areas (National Development Plan 2010-2015).

In order to reduce poverty and sustain economic growth, the World Bank recommends that Uganda should target the transformation of the agriculture sector by increasing the sector's output and productivity and by increasing value addition through food processing for export in regional and international markets (World Bank Country Brief, Uganda, 2011). In addition, there is need to increase non-farm income generating opportunities to absorb the rapidly increasing labour force. If government policies targeted improved farm household incomes and employment, the question we ask is that what are the economy wide growth and welfare implications of such policies and who are the most affected agents? Put in a different way, how and which sectors and economic agents would be most affected by exogenous policy shocks that target growth and poverty alleviation? This dissertation seeks to answer this question by examining the micro and macroeconomic effects of exogenous policy changes in line with the country's growth and poverty reduction strategies as mentioned in the

National Development Plan (Poverty Reduction Strategy Paper, 2010). Thus, the results from this dissertation could generate policy prescriptions for the government and guide policy makers to target those sectors with significant impact on household incomes distribution, employment and welfare in order to alleviate poverty and sustain growth. For example, if our results suggested that increasing agricultural exports had a significant impact on employment and incomes of rural households and unskilled labour relative to their urban counterparts, the appropriate policy recommendation to reduce rural poverty would be to sensitize farmers on new farming methods, provide inputs, and invest in feeder roads to link farmers to markets among others.

1.3 Challenges to Sustainable Economic Growth and Poverty Alleviation

Further, Uganda continues to face challenges that have made it difficult to achieve the much needed socio-economic transformation (IMF Country Report, 2010). These include: the country has not achieved significant productivity growth in agriculture that would release excess labour to other sectors; there are a number of structural characteristics that hinder the country's growth and poverty reduction prospects that need to be addressed. Key among these include: first, the large proportion of primary products over manufactured products which signifies that the growing new sectors have not contributed significantly to value added exports and are thus not outward oriented; secondly, the slower than desirable growth of the agricultural sector relative to the service and industrial sectors; thirdly, growth in the service and manufacturing sectors is not enough to absorb the increasing labour force; the country has limited fiscal resources, with a tax ratio to GDP of 13 percent being smaller compared to her East African neighbors Kenya and Tanzania at 27 percent and 17 percent respectively during the period 2007/2008 (Ssewanyana *et al*., 2010); and capital markets that are not mediating capital. This dissertation seeks to identify among other things, key sectors and policies that could greatly offer a wide range of policies that would alter these undesirable economic features and provide opportunities for sustainable growth and poverty reduction.

1.4 Justification for the SAM-CGE Modeling Framework

The methodology employed to answer the main research question (i.e. what are Uganda's key sectors for growth? and what are the welfare implications that can be derived from external shocks taking into consideration the socio-economic challenges the economy faces?), comprises of a two economy wide modeling system: First, we use the Social Accounting Multiplier (SAM) decomposition technique and Computable General Equilibrium (CGE) model. The SAM is a comprehensive, disaggregated, consistent and complete data system that captures the interdependence that exists within a socioeconomic system (Thorbecke, 2000). Alternatively the SAM can be used as a conceptual framework to study the impact of exogenous changes in such variables as exports, certain categories of government expenditures, and investment on the whole interdependent socioeconomic system, e.g. the impact on household and factorial income distribution. As such the SAM becomes the basis for simple multiplier analysis and the building and calibration of a variety of applied computable general equilibrium models (CGE). The key strength of the SAM is that it explicitly breaks down households into relatively homogenous socioeconomic categories that are recognizable for policy purposes and exhibit relatively stable characteristics. This type of disaggregation is very critical when using the SAM to analyse the effects of various policies on income distribution (Thorbecke, 2000).

It should be noted that for the SAM to be used as a model, a number of assumptions must be taken into account. First, prices are assumed fixed and any changes in demand lead to changes in physical output rather than prices. This implies that the economy's factor resources are unlimited or unconstrained such that any increase in demand is matched by a corresponding increase in supply (excess capacity). Secondly, production technology and resource endowments are assumed given (i.e. the analysis is a short-term analysis with no dynamics at all). Third, average expenditures propensities of endogenous accounts remain constant (i.e. linkage effects are linear and there is no behavioral change). The SAM multiplier model is suited for the analysis in this dissertation because it generates both production and consumption linkages compared to the traditional input-output model (Thurlow *et al*., 2010), making it suitable for the choice of key sectors for growth and poverty alleviation, a potential research question that this study seeks to address. In addition, the SAM multiplier decomposition model enhances our understanding of the impact of exogenous shocks on the entire socio-economic system by separating the aggregate impact of the shock into three main effects. These are transfer, spill over (cross effects) and the feedback or closed loop effects (Stone, 1978). It is worth noting that our study goes beyond those that have applied the traditional input-output approach and SAM models in addressing poverty, income distribution and growth prospects in developing countries (World Bank 1995; 2003 for Lesotho; Thurlow, 2004; for Zambia; and Sarris, 2001). In fact, this dissertation extends these analyses in two ways; namely, by incorporating the causal linkages underlying the structural features of Uganda’s economy through the SAM multiplier decomposition technique; and the use of a computable general equilibrium (CGE) model.

Computable General Equilibrium (CGE) models offer a comprehensive way of modeling the overall impact of policy changes on the economy. They are completely-specified models of an economy or a region, including all production activities, factors and institutions. Such models include the modeling of all markets and macroeconomic components, such as investment and savings, balance of payments, and government budget. In addition, CGE models incorporate many economic linkages and can be used to try to explain medium- to long-term trends and structural responses to changes in development policy (World Bank, 2011).

Further, in a real world at least some sectors in the economy operate at full capacity and some factors of production (e.g. skilled labor) are fully employed. Under those circumstances prices can no longer remain constant as assumed in the SAM multiplier model. A modeling framework that takes into account changes in factor prices and institutional characteristics is necessary to examine the impact of policy shocks on the economy. Given the economy wide nature and the strong general equilibrium effects of such shocks, most of them have been ideally analysed using computable general equilibrium (CGE) models with a specific SAM as their data base. The CGE model for Uganda is presented in Chapter 7 and the SAM is presented in appendix C.

In a computable general equilibrium (CGE) model, prices are endogenously determined so as to generate the set of prices that are consistent with equilibrium in an economy. When an economy is affected by an exogenous shock or a policy change, a new set of prices obtains, which, in turn, determine production, consumption, employment and incomes. Both the SAM multiplier and CGE models are based on two fundamental pillars (i.e. that interaction and interdependence within a socioeconomic system matters as does the prevailing structure). Further, what CGE models add to the simple SAM framework is that they capture the behavior of the main actors in response to price changes (Thorbecke, *et al*., 2000).

In using a computable general equilibrium (CGE) model, we avoid the unrealistic assumptions of the SAM multiplier model (i.e. fixed prices, linearity of input technology, no input substitution). The SAM based computable general equilibrium model assumes factor substitution which is incorporated in the choice of the production functions. In addition, and to answer one of the research questions in this study: what are the distribution effects of various polices on household welfare and employment? The World Bank recommends the use of CGE modeling as a tool in the analysis of the distributional impacts of various policies on the socioeconomic system (The World Bank, 2011; Thurlow *et al*., 2002). It is worth mentioning that this study is the first of its kind to apply the SAM multiplier decomposition approach and CGE analysis to identify key sectors, and to concurrently analyse the impact of exogenous policy shocks on welfare in Uganda.

As mentioned earlier, the purpose of this dissertation is not to measure poverty but to make recommendations on how to alleviate poverty by analysing the distributional impact of selected exogenous changes and policies. These experiments are chosen mindful of the country's socioeconomic challenges mentioned in the National Development Plan. Experiments to be performed include: An increase in the world price of exports; an increase in migrant workers remittances; a decline in import tariffs; and an increase in foreign direct investment or foreign savings. The macro and microeconomic effects of these experiments are presented and evaluated.

Using the SAM multiplier model, our findings suggest that one of the research questions this dissertation sought to address was adequately answered. It's clear from the calculated multipliers that Uganda's economy is weakly integrated i.e. small multipliers might imply that sectors of activity are independent of what takes place in other sectors of the economy (Nganou, 2005). Similarly, the SAM multiplier and CGE models suggest that Agriculture, Other Services, Food Processing, and Trade Service are key sectors[4] for growth and poverty reduction prospects in Uganda. Given the challenges of Uganda's economy, policy makers can stimulate the economy by targeting the key sectors in order to achieve the growth and poverty alleviation targets. If for example an increase in exports led to an increase in rural

[4] A key sector has both forward and backward linkages that are greater than one.

employment and growth, policy interventions should focus on the agriculture sector (i.e. by providing incentives to farmers to increased production for food processing and exports). Such intensives might include: free training on better methods of farming, provision of subsidised inputs, and access to microcredit. The agriculture sector would then supply her output as inputs to Food Processing, Textiles, and Manufacturing given its strong forward linkages with these sectors. The demand for the output of the agriculture sector would then create more jobs for rural workers. Agriculture is the dominant employer of low skilled labour in Uganda (i.e. employs over 75 percent of labour force) and the increase in the sectors output would have significant employment and welfare implications.

The reminder of the dissertation is organized as follows: Chapter 2 presents a detailed discussion of Uganda's economic background; Chapter 3 discusses the literature survey and methodology; Chapter 4 discusses the basic features of the Uganda's economy based on the 2002 social accounting matrix; Chapter 5 discusses the results of the SAM multiplier model. The structure of the CGE model for Uganda is discussed in Chapter 6; Chapter 7 presents the economy wide simulation results of selected exogenous changes and policy shocks; the effects of these changes and policy shocks on welfare and inequality are presented in Chapter 8. Concluding remarks and policy recommendations are discussed in Chapter 9. Finally, appendices A to C give the sets, parameters, and variables used in the CGE model for Uganda and the GAMS code used to perform simulations. A detailed description of closure rules and their GAMS codes, the disaggregated SAM, and references follow in that order.

Chapter 2

Uganda's Economic Background

2.1 Background Information

Uganda was one of the first African economies to embark on economic liberalisation since the late 1980s. Between 1990 and 2000, the country implemented of a wide range of structural reforms. As a result, the country was one of the fastest growing economies in Africa with real GDP growth averaging 7 percent per annum. However, this growth has not been sustainable in order for real per capita income to rise beyond the current US$506. With the implementation of the first Poverty Eradication Action Plan (PEAP, 2003/2004), growth varied between 6.8 percent between 2000 and 2004 and 8 percent between 2004 and 2008. Uganda's economy is projected to grow at an average rate of 7.2 percent per annum with the full implementation of the policy recommendations outlined in the Poverty Reduction Strategy Paper (PRSP, 2010). If GDP grows at this rate, per capita GDP is expected to reach US $850 by 2014/2015 up from US $506 in 2008/2009. Uganda's growth over the years has remained well above Sub-Saharan Africa average. However, due to rapid population growth, per capita real GDP growth averaged only 3.4 percent in the 1990s and has averaged 4 percent in the last two decades (World Bank, Uganda Country Brief, 2011). Due to broad based economic growth, Uganda has performed well with regard to reducing absolute poverty. The national poverty headcount fell from 56 percent in 1999 to 31 percent in 2005/2006. Recent estimates put the national poverty headcount at 24.5 percent, implying that Uganda has achieved her first millennium development goal of halving absolute poverty between 1990 and 2015 (PRSP, 2010/2011-2014/2015).

Following years of economic mismanagement of the late 1970s and mid-1980s, the government embarked on the implementation of structural reforms all which were aimed at restoring macroeconomic stability. The overall outcome of the reform efforts was the growth of the economy at an average rate of 6.3 percent per annum for the fifteen fiscal years starting from 1987/1988. The fastest growing sectors were the small ones such as mining and quarrying, manufacturing, hotels and restaurants, and construction. Community services (education, health and general government services), which in 2002/2003 accounted for 19.1percent of GDP, grew at an average rate of 6.8 percent between 1987 and 2002 (Ssewanyana *et al.*, 2005). This was slightly higher than the average GDP growth rate of 6.3 percent. The growth of community services was partly attributed to increase in donor-supported public spending on these sectors.

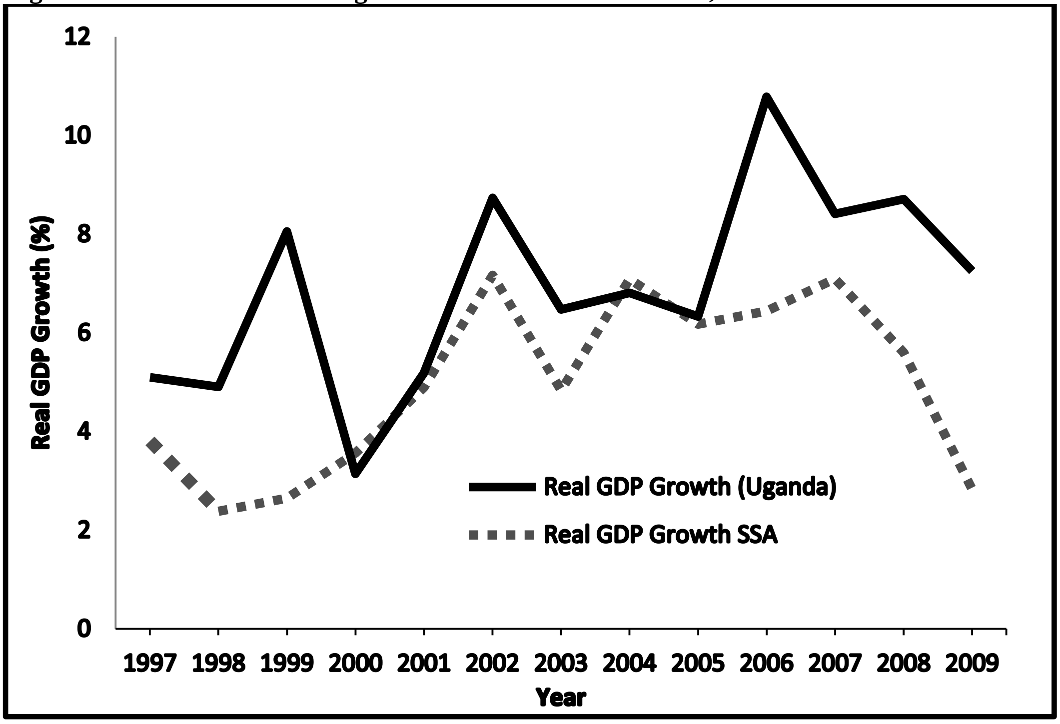
The liberalisation of the coffee sector and privatization of public enterprises in the 1990s led to significant economic growth and reduction in the national poverty headcount from 56 percent in 1999 to 31 percent in 2002. At the height of these reforms, the economy experienced structural shifts, with the share of agriculture in value added GDP declining from 56.1 percent to 41 percent between 1986 and 1999, and to 40.5 percent in 2001. During this period, investment as percentage of GDP increased by 8.4 percent and 19 percent respectively, and thereafter increased by 20.7 percent in 2002. The share of exports in GDP rose from 5.8 percent to 11.8 percent during the same period. However, the share of imports in GDP increased by 8.6 percent in 1985/1986 and by 24.2 percent in 1998/1999, and thereafter by 27.7 percent in 2001/2002.

Government revenue as a percentage of GDP (excluding grants) was 6.6 percent in 1987, 11.6 percent in 1999, and 12.6 percent in 2009. During this time, donor support accounted for over 50 percent of Uganda’s budget which suggests that the country remained highly dependent on external support with limited domestic resources to implement various socioeconomic programs. Growth was therefore spearheaded by increase inflows of donor funds, private sector investment in industry and construction sectors. Agriculture is Uganda’s dominant employer and foreign exchange earner but the sector has not grown faster relative to the services and industrial sectors (Poverty Reduction Strategy Paper, 2010). In addition, the persistent decline in value added by agriculture relative to the manufacturing and service sectors has serious implications to Uganda's growth and poverty reduction strategies. Agriculture grew at an average rate of 5.6 percent between 1987 and 2003 (Ssewanyana *et al.,* 2005), and at 2.6 percent in 2009. At this rate, the agriculture sector has grown slowly compared to the service and manufacturing sectors. Growth in the manufacturing and service sectors averaged 6.3 percent during this period. Thus, the faster growth of small sectors with limited linkages to the rest of the economy could explain why growth was achieved with increasing inequality of income (Okidi *et al*., 2007). Consequently, the service sector has been the primary driver of growth for Uganda's economy during the reform period, with its share in GDP increasing to 50 percent (Bank of Uganda, 2010).The rapid growth of service sectors which mostly employ high skilled labour and is predominantly urban based presents enormous challenges to Uganda's growth and poverty reduction prospects given that agriculture is the backbone of Uganda's economy (i.e. the sector employs about 70 percent of the total labour force, supplies all domestic food requirements; and supplies almost all the inputs used in the manufacturing sector. However, output in the agriculture sector has not grown in tandem with the rest of the economy.

2.2 GDP Components and Growth Performance

Between 1987 and 2007, Uganda's economy registered an impressive growth rate of 7.7 percent. In fact, Uganda's economic growth during this period was higher compared to growth in Sub-Saharan Africa (Figure 2.2.1).

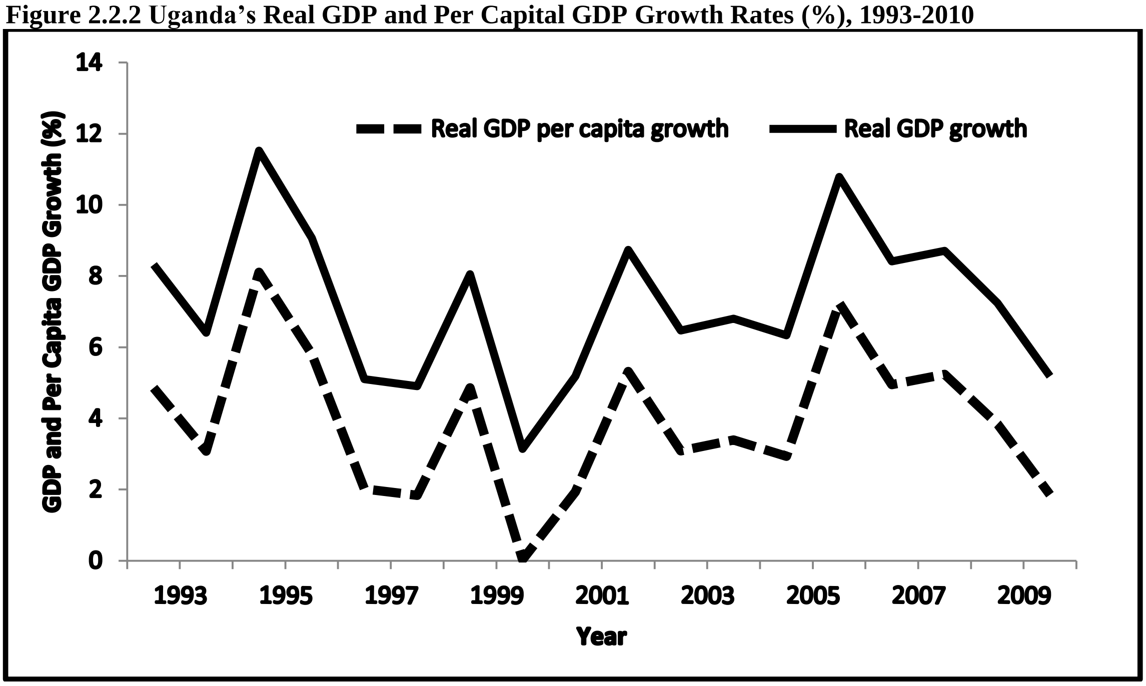
Figure 2.2.1 GDP Growth in Uganda and Sub-Saharan Africa, 1997-2009



Source: World Bank, World Development Indicators 2010. SSA is Sub-Saharan Africa.

The economy registered an average growth rate of 6.8 percent between 1997 and 2009 and per capita income averaged 4.2 percent during the same period. Overall, GDP grew more than the growth rate of per capita income (Figure 2.2.2).

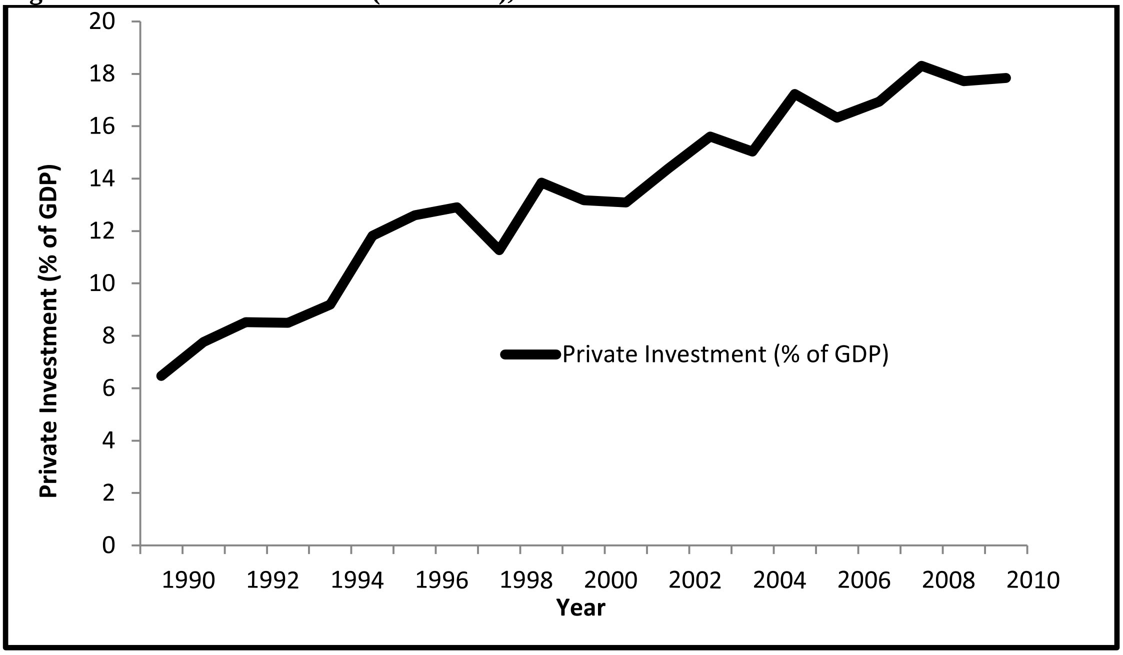
Figure 2.2.2 Uganda's Real GDP and Per Capital GDP Growth Rates (%), 1993-2010



Source: World Bank, World Development Indicators Databases 2010.

Uganda's growth in the early 1990s was driven by a combination of macroeconomic and structural reforms. Key among these reforms was the increase in private sector participation in economic activities led primarily by investment in services (banking, telecommunication, and construction). Private investment as a percentage of GDP increased by 6.5 percent and 14 percent in 1990 and 2000 respectively (Figure 2.2.3). The share of private investment in GDP increased further by 15 percent and 18 percent in 2008 respectively.

Figure 2.2.3 Private Investment (% of GDP), 1990-2010

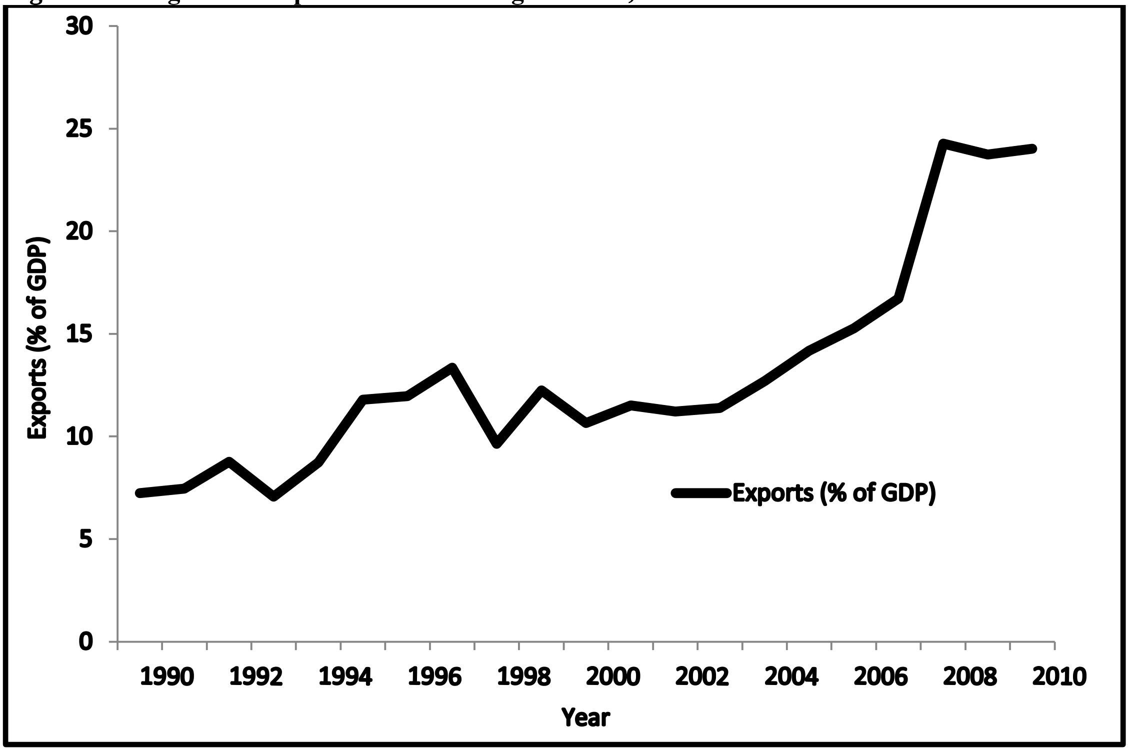


Source: World Bank, World Development Indicators Data Base 2010.

Trade liberalization was another reform that was aimed at increasing the volume of Uganda’s exports so as to improve the country’s trade and current account balances. The increase in exports contributed to economic growth, with the share of exports in GDP increasing by 7 percent and 13 percent in 1989 and 1997 respectively. The share of exports in GDP increased by 24 percent in 2010 (Figure 2.2.4). This was mainly due to increased demand for Uganda‘s processed food products by trading partners from the East African Community[5] (Bank of Uganda Annual Reports, 2009). The share of exports in GDP increased further between 2008 and 2010, averaging 24 percent of GDP.

[5] East African Community: A regional grouping comprising of Uganda, Kenya, Rwanda, Tanzania, Burundi, and the republic of South Sudan.

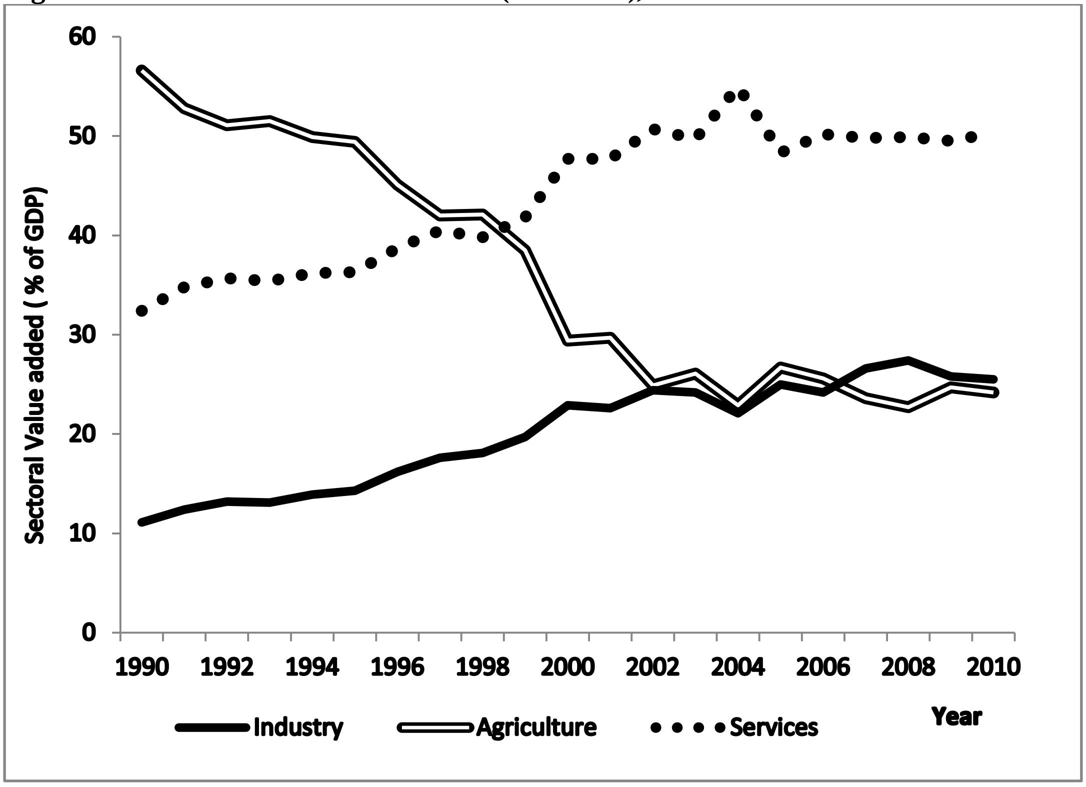
Figure 2.2.4 Uganda's Exports as a Percentage of GDP, 1990-2010



Source: World Bank, World Development Indicators Database 2010.

With regard to sectoral composition of GDP, the service sector is Uganda's main source of output, contributing over 50 percent of GDP since 2001. On the other hand, the share of agriculture value added in GDP has not increased significantly relative to the share of services and industrial sectors. The share of agriculture in GDP declined from 56 percent in 1990 to 24.9 percent in 2002. However, the share of manufacturing in GDP increased by 11 percent and 24.4 percent in 1990 and 2002 respectively. On the other hand, the share of services in GDP was 32.4 percent and 50 percent in 1990 and 2002 respectively (Figure 2.2.5). Currently, the service sector is the primary source of economic growth in Uganda, contributing about 50 percent to real GDP and growth.

Figure 2.2.5 Sectoral Value Added Shares (% of GDP), 1990-2010

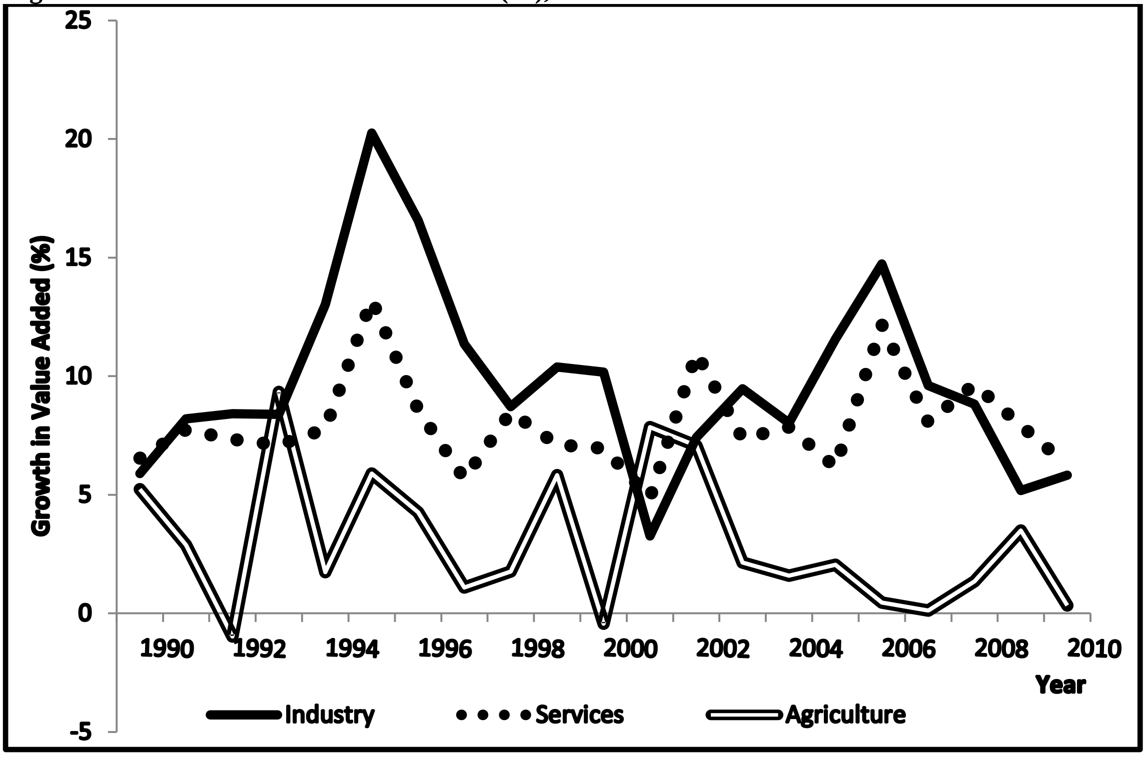


Source: World Bank, World Development Indicators Data Base 2010.

The declining share of agriculture in GDP highlights the challenges policy makers in Uganda face in sustaining economic growth performance and alleviating poverty especially in rural areas where agriculture supports the livelihoods of over 80 percent of the population, contributes over 75 percent of export earnings, and supplies all the inputs used in the industrial sector (Uganda Human Development Report 2007). It should be noted that the value added share of the industrial sector in GDP which averaged 20 percent between 1990 and 2010 is well below the 35 percent benchmark for countries graduating from low to middle income status (Bevan *et al*., 2003).

Growth in value added by the industrial sector declined from 8.8 percent in 2007/2008 to 5.2 percent in 2008/2009 (Figure 2.2.6) largely as a result of the global economic crisis, which led to a decline in workers remittances that had initially led to a construction boom (Ssewanyana *et al*., 2010).

Figure 2.2.6 Sectoral Value Added Growth (%), 1990-2010



Source: World Bank, World Development Indicators Data Base, 2010.

Table 2.2.6 Growth in Sectoral Value Added in Uganda (%), 1990-2010

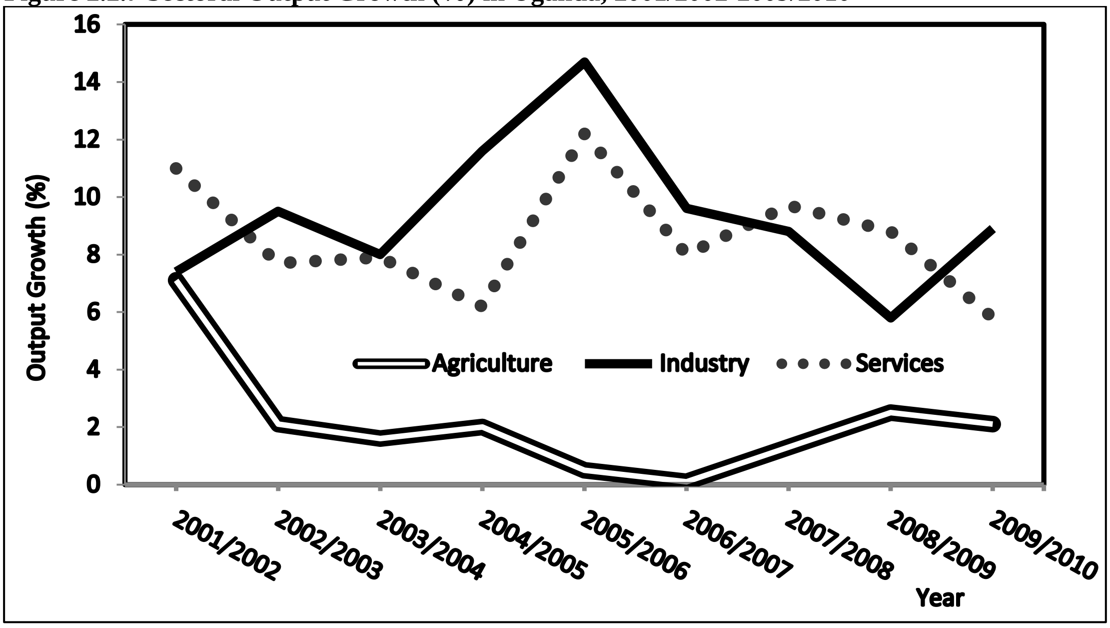
Year	Industry	Services	Agriculture
1990	5.9	6.5	5.2
1991	8.2	7.7	2.9
1992	8.4	7.3	-1.0
1993	8.4	7.1	9.3
1994	13.0	7.8	1.7
1995	20.3	13.2	5.9
1996	16.6	8.6	4.3
1997	11.4	5.7	1.1
1998	8.7	8.5	1.8
1999	10.4	7.1	5.8
2000	10.2	7.0	-0.4
2001	3.3	4.9	7.9
2002	7.4	11.0	7.1
2003	9.5	7.4	2.1
2004	8.0	7.9	1.6
2005	11.6	6.2	2.0
2006	14.7	12.2	0.5
2007	9.6	8.0	0.1
2008	8.8	9.7	1.3
2009	5.2	7.9	3.5
2010	5.8	6.3	0.3

Source: World Bank, World Development Indicators Data Base 2010.

The decline in migrant workers remittances caused the share of the construction subsector in GDP to decline from 10.8 percent in 2007/2008 to 3.7 percent in 2008/2009 (Bank of Uganda Annual Reports, 2008/2009). The decline in the share of the industrial sector in GDP was partly attributed to the increase in imported inputs caused by the depreciation of the exchange rate. The contribution of the manufacturing subsector to overall GDP was well below that of the construction subsector. This dissertation analyses the economy wide effects of increased workers remittances (Chapter 7).

Output growth in the industrial sector increased by 7.4 percent in 2001/2002 and 9.5 percent in 2002/2003 (Figure 2.2.7). Similarly, growth in industrial sector output increased by 5.8 percent and 8.9 percent in 2008/2009 and 2009/2010 respectively. During the same period, output in the service sector grew by 11 percent in 2001/2002 before declining to 7.4 percent in 2002/2003. Output growth declined from 9.7 percent to 8.8 percent between 2007/2008 and 2008/2009, before declining by 5.8 percent in 2009/2010 (Table 2.2.7).

Figure 2.2.7 Sectoral Output Growth (%) in Uganda, 2001/2002-2009/2010



Source: Uganda Bureau of Statistics (UBOS), 2010.

Table 2.2.7 Sectoral and Sub-sectoral Output Growth (%) in Uganda, 2001/2002-2009/2010

	2001/2002	2002/2003	2003/2004	2004/2005	2005/2006	2006/2007	2007/2008	2008/2009	2009/2010
GDP at Mkt Prices	8.6	6.6	6.8	6.3	10.8	8.4	9	7.2	5.8
Agriculture	**7.1**	**2.1**	**1.6**	**2**	**0.5**	**0.1**	**1.3**	**2.5**	**2.1**
Cash crops	12.5	3.2	7.3	-5.5	-10.6	5.4	2.4	5.6	-2.9
Food crops	5.7	2.2	-1.5	-0.2	-0.1	-0.9	9.1	2.6	2.7
Industry	**7.4**	**9.5**	**8**	**11.6**	**14.7**	**9.6**	**3**	**5.8**	**8.9**
Mining	12.2	12.8	1.7	27.2	6.1	19.4	7.6	4.3	12.8
Manufacturing	6.7	4.4	6.3	9.5	7.3	5.6	10.8	10	5.9
Construction	10.1	14.6	10	14.9	23.2	13.2	10.2	3.7	10.9
Services	**11**	**7.4**	**7.9**	**6.2**	**12.2**	**8**	**21.3**	**8.8**	**5.8**
Transport & Comm	17.8	14.9	15.8	9.8	17.1	17.7	22.6	14.3	15.1
Posts and Telecom	76.5	40.4	28.6	11.8	26.2	29.1		19.8	2.8

Source: Uganda Bureau of Statistics (UBOS), 2010. All components valued in 2002 current prices.

The agriculture sector grew at 2.5 percent in 2009/2010 (Table 2.2.7). This rate was twice the growth rate of the same sector in 2007/2008. However, this growth rate is well below the 6 percent annual growth rate recommended by the Comprehensive Africa Agriculture Development Program (CAADP) for Uganda to effectively reduce the proportion of people living in extreme poverty and hunger (Thurlow *et al.,* 2007). This contribution of the agriculture sector to Uganda's prospect for growth and poverty alleviation will be analyzed by using a shock to world export prices (Chapter 7).

The growth of real GDP in Uganda is heavily dependent on private consumption expenditure. Under the expenditure approach, private consumption expenditure on average contributed about 5.8 percent of the 7.6 percent growth in real GDP (76 percent of overall real GDP growth) between 2001/2002 and 2009/2010 (Tables 2.2.8 and 2.2.9). Government consumption expenditure contributed about 1.1 percent of the average 7.6 percent annual growth in real GDP (14 percent of overall real GDP growth). Investment expenditure (public and private) contributed 1.6 percent of the 7.6 percent growth in real GDP (about 22 percent of the total) during the same period. Expenditure on imports contributed about 2.1 percent to average annual growth in real GDP (about 28 percent of the total) between 2001/2002 and 2009/2010. It should be noted that if private consumption is by the rich households and firms, this could have welfare implications to Uganda's economy. This dissertation seeks to identify exogenous changes and policies that affect the welfare of households bearing in mind that household income distribution affects the pattern of private consumption expenditure and consequently, economic growth in Uganda.

Table 2.2.8 Shares in real GDP Growth by Expenditure Components (%), 2001/2002-2009/2010

Year	Private Cons	Govt cons	Investment	Exports	Imports	Total
2001/2002	77.4	15.6	19.3	11.5	23.8	100
2002/2003	76.8	16.8	20.2	11.2	25.1	100
2003/2004	77.1	15.7	21.0	11.4	25.2	100
2004/2005	76.0	13.9	20.1	12.7	22.8	100
2005/2006	73.8	14.5	22.4	14.2	24.8	100
2006/2007	77.8	14.1	21.1	15.3	28.4	100
2007/2008	78.4	12.9	22.1	16.7	30.1	100
2008/2009	73.5	11.2	23.0	24.3	32.0	100
2009/2010	75.7	11.6	24.1	23.7	35.2	100
Average	76.3	14.0	21.5	15.7	27.5	100

Source: World Bank, World Development Indicators Databases 2010.

Table 2.2.9 Real GDP Growth by Expenditure Components (%), 2001/2002-2009/2010

Year	Private Consumption	Government Consumption	Investment	Exports	Imports	Real GDP Growth
2001/2002	4.0	0.8	1.0	0.6	1.2	5.2
2002/2003	6.7	1.5	1.8	1.0	2.2	8.7
2003/2004	5.0	1.0	1.4	0.7	1.6	6.5
2004/2005	5.2	0.9	1.4	0.9	1.5	6.8
2005/2006	4.7	0.9	1.4	0.9	1.6	6.3
2006/2007	8.4	1.5	2.3	1.6	3.1	10.8
2007/2008	6.6	1.1	1.9	1.4	2.5	8.4
2008/2009	6.4	1.0	2.0	2.1	2.8	8.7
2009/2010	5.5	0.8	1.7	1.7	2.5	7.2
Average	5.8	1.1	1.6	1.2	2.1	7.6

Source: Compiled by Author. Data is from World Bank, WDI Data Bases 2010.

2.3 Structural Transformation and Agriculture Sector Performance

A number of challenges have prevented Uganda from achieving faster economic growth and the much needed socioeconomic transformation. The country has not achieved significant productivity growth in agriculture and thus the sector has not released excess labour to other sectors. While there have been changes in the sector composition of GDP, there has not been a significant change in the distributional pattern of the labour force. The GDP share of the emerging new sectors is increasing but their share of the labour force is falling. The share of the labour force employed in manufacturing declined from 6.8 to 4.2 percent between 2002 and 2006, while that of services fell from 26.8 percent to 20.7 percent during the same period despite the increase in GDP shares of these sectors (Poverty Reduction Strategy Paper, 2010). However, the share of the labour force engaged in the agriculture sector increased from 66.4 percent in 2002/2003 to 75.1 per cent in 2005/2006 while the share of agriculture in GDP declined over the same period. This may be attributed to a variety of factors namely: a mismatch between skills acquired and the job requirements, the development of low skilled services and industries, the high rate of growth in the labour force, and the inability to absorb it in the emerging sectors. These trends contribute to low productivity in agriculture which undermines the growth potential of the economy and exacerbate the problem of food insecurity.

Although the value added share of agriculture in GDP has remained low than that of the service and industrial sectors, its share in active employment remains high (about 70 percent). Services, which account for 50 percent of real GDP growth, employ only 24 percent of the labour force. Employment in industry, which account for more than 25 percent of real GDP growth, is also very minimal, at about 8 percent of the total active labour force (Table 2.3.1). The sectoral composition of employment by gender (Table 2.3.2) suggests more females were employed in agriculture (76 percent) compared to men (62 percent). Similarly, services employed more male workers (27.6 percent) than females (19.2 percent). Meanwhile, the share of male employees in industry (10 percent) was twice that of female employees (5 percent) between 2002 and 2003.

Table 2.3.1 Employment Shares by Sector in Uganda, 1992/1993-2002/2003

Sector	1992/1993	1999/2000	2002/2003
Agriculture	81.5	79.7	69
Industry	4.6	4.1	7.6
Services	13.9	16.2	23.5
Total	100	100	100

Source: World Bank World Development Indicators Data Base 2010. Sectoral employment is expressed as share of total active labour force.

Table 2.3.2 Sectoral Shares of Employment by Gender, 2003

Sector	Male employees (% of total male employment)	Female employees (% of total female employment)
Agriculture	61.8	75.7
Industry	10.3	5.3
Services	27.6	19.2
Total Employment	100	100

Source: World Bank World Development Indicators Data Base 2010.

Even though the growth rate of employment in Uganda has been positive over time and consistent with the overall composition of GDP, it has been well below the growth rate of GDP (Appleton *et al*., 2004). This is attributed to low labour productivity in most sectors. In fact, employment in agriculture, Uganda's largest employer is dominated by low skilled labour. About 90 percent of the total agricultural labour force is low skilled, and dominated by female employees (Uganda National Household Survey, 2002/2003). This has implications on agriculture's contribution to real GDP and poverty alleviation in rural as well as urban areas.

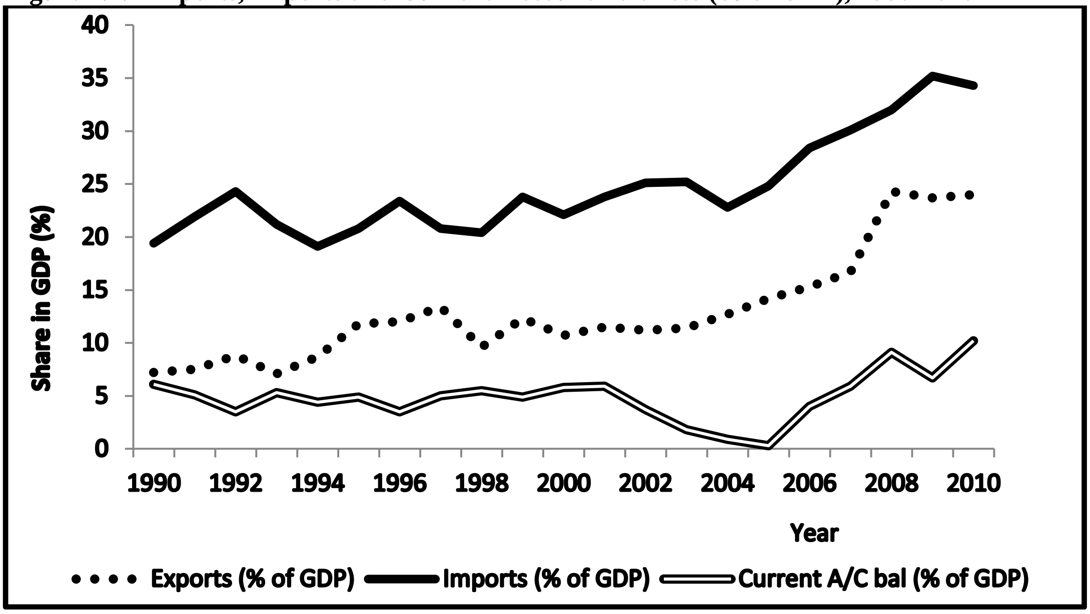
Agriculture in Uganda is characterised by low productivity due to poor production methods, underdeveloped value chains, and limited public and private sector investment (Ssewanyana *et al*., 2010). In addition, the lack of diversification and low productivity growth in the sector makes it harder to alleviate poverty especially in rural areas. The agricultural reforms that were implemented during the 1990s are partly to blame for the poor performance of the sector. The dismantling of cooperatives and liberalization of the economy, led to greater participation of the private sector in marketing agricultural produce. Poor farmers in rural areas were therefore paid less than the market value of their produce. In addition, these reforms largely benefited only a small fraction of farmers, particularly richer and better-educated farmers who are endowed with high skilled labour and were able to diversify their farming activities for higher returns. Once these efficiency gains were exploited, other innovations were needed to maintain output growth in the sector (Okidi *et al*., 2007). About 50 percent of agriculture output in Uganda is marketed. Marketed output includes coffee, and other tradable with niche markets (i.e. fish, flowers, vanilla, and tomatoes). Most output from smallholder farmers is meant for subsistence consumption and in most cases such farmers are generally poor regardless of the level of economic activity. Government programs to modernize the agriculture sector through increased food production and processing, value addition and exports have not contributed to agriculture sector growth. As a result, the sector's contribution to growth and poverty alleviation has not been fully maximized.

2.4 The Trade Sector

2.4.1 Export and Import Performance

The share of exports in GDP has increased over time in Uganda (Figure 2.4.1). Before the liberalization of the economy and the emphasis on import substitution and export diversification of the 1990s, Uganda depended mainly on coffee as its main export. This dependence on a single export commodity whose global market prices kept fluctuating had implications on the country's terms of trade. When coffee prices fell in mid 1990s, the country experienced adverse terms of trade and persistent current account deficits.

Figure 2.4.1 Exports, Imports and Current Account Balances (% of GDP), 1980-2010



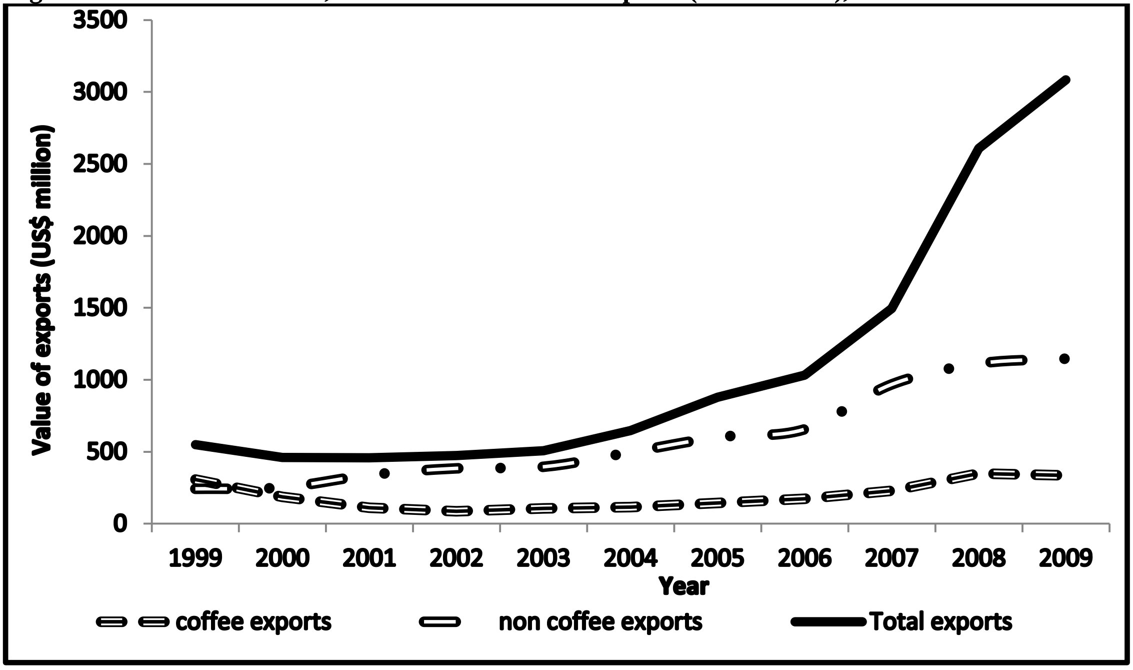
Source: World Bank, World Development Indicators Data Base 2010. Current account balance is the sum of net exports of goods, services, net income, and net current transfers.

To insulate the economy from adverse terms of trade and instability in export earnings associated with commodity concentration, the government adopted a policy shift in 1987 that sought to diversify the export base to include non-traditional agricultural export crops[6]. Since then, Uganda has diversified its export base to include larger shares of cut flowers, fishing, and other agricultural exports. With the

[6] Non-traditional exports include: maize, beans, vanilla, soya beans, cut flowers, fish and its products.

diversification of the export sector, the value of total exports increased (Figure 2.4.2). Earnings from non-coffee exports increased significantly between 1999 and 2010, rising from US$242 million to US$1,350 million. Export earnings were further boosted by the increase in the value of non-traditional[7] and informal cross border exports.

Figure 2.4.2 Value of Coffee, Non-Coffee and Total Exports (US$ Million), 1999-2009



Source: Bank of Uganda Annual Reports 2008/2009. Total Exports is the sum of coffee and non-coffee exports. Non-coffee exports include other tradition export crops (cotton, tea, and tobacco) and non-traditional exports (gold, fish, Cut flowers, beans, maize, vanilla etc.) and informal cross border exports.

The increase in non-coffee exports alongside informal cross border trade[8] whose share increased from 1.3 percent in 2002/2003 to 50.2 percent in 2008/2009 was a major boost to Uganda's economy given the fact the global financial crisis had affected earnings from traditional exports crops, mainly dominated by coffee (Ssewanyana *et al*., 2010). Including informal cross-border trade, the share of industrial products in total exports increased from 43.8 percent in 2007/2008 to 54.9 percent in 2008/2009 (Bank of Uganda Annual Reports, 2009). As new emerging

[7] Exports include fish and its products, beans, maize, cut flowers, hides and skins, and simsim.

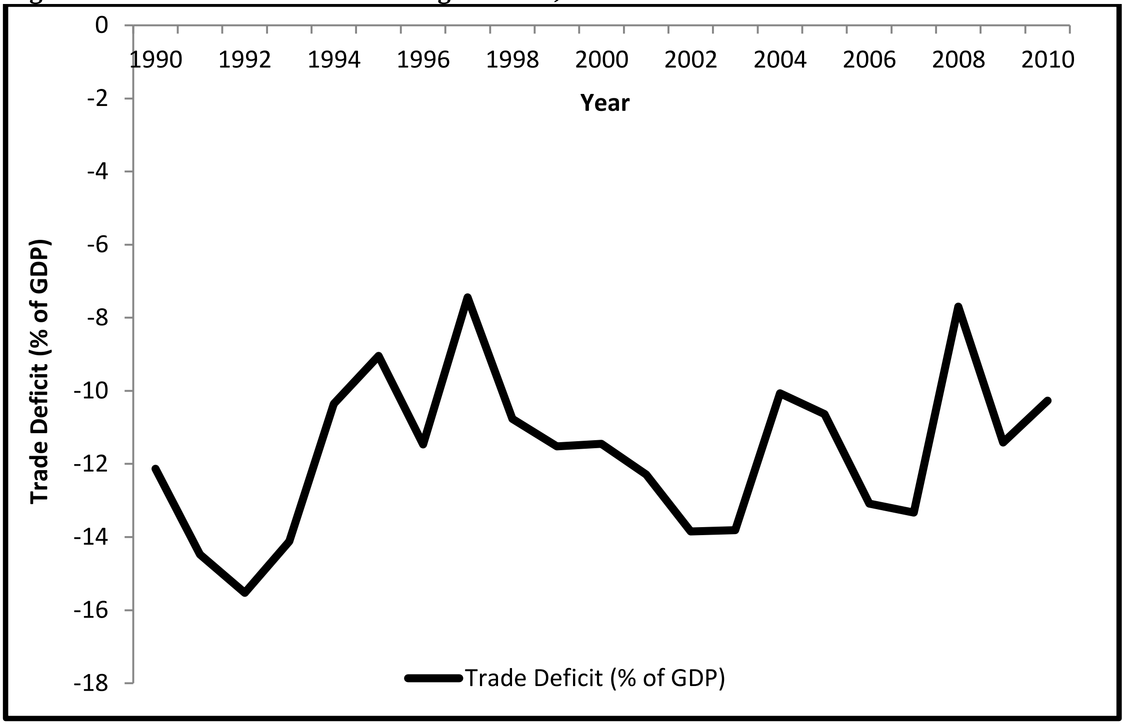
[8] Trade which is not captured in official trade statistics. Data on informal cross border trade are necessary for both accurate balance of payments and national account statistics (Uganda Informal Cross Border Trade Survey Report, June 2011).

regional export markets[9] expand, Uganda will have to increase her exports in order to reap the benefits of increased cross-border trade.

Trade liberalisation was designed to reverse and even eliminate the trade deficit by increasing export earnings and curtailing the demand for imports. Incentives for export-oriented trade and market-determined exchange rate policies were expected to encourage both traditional and non-traditional exports. Nevertheless, merchandise exports continued to decline throughout the liberalization period (1987-1992), partly because the manufacturing sector had shrunk as a result of economic mismanagement in the 1970s and early 1980s. Since 1987, the volume of trade has been increasing, mainly dominated by highly valued imports. The increase in the volume and value of imports relative to exports has led to persistent balance of trade and current account deficits (National Development Plan, 2010). Uganda's trade deficit has been widening despite improvements in the composition and value of exports. The trade deficit as a percentage of GDP declined from an annual average of 12.9 percent between 2000/2001 and 2003/2004 to 13.5 percent between 2004/2005 and 2007/2008 (Figure 2.4.3). The current account balance has also been unfavorable with a deteriorating trend in recent years, raising from 0.3 percent of GDP in 2005 to 9.1 percent of GDP in 2009. This could partly be explained by lower demand for Uganda's exports in advanced economies due to their unprocessed nature and competition from more advanced exports from Uganda's trade partners (PRSP, 2010/2011-2014/2015); and falling remittances due to the global economic crisis.

[9] Markets include the East African Community (EAC) and the Common Market for Eastern and Southern Africa (COMESA).

Figure 2.4.3 Trade Deficit as Percentage of GDP, 1990-2010



Source: World Bank, World Development Indicators Databases 2010.

The IMF has suggested that there is need to expand the Uganda's export base if growth is to be sustained. However, this requires significant investment in the agriculture sector. Export competitiveness must be enhanced through value addition and processing in order to fetch high foreign exchange earnings. Export led growth through agro-processing and industrialization is one of the key pillars of Uganda's National Development Plan (IMF Country Poverty Reduction Strategy Paper, 2010). Meanwhile, the role of trade in alleviating poverty and fostering growth in Uganda has been previously studied (Mbabazi *et al*., 2002; Matovu *et al*., 2008). In fact trade policies can impact on poverty, growth and employment (Winters *et al.*, 2004, Bedia, 2006; Ganuza *et al*., 2005). This dissertation builds on this strand of literature to analyse the impact of trade liberalization (i.e. through tariff cuts) on output growth, employment, and household welfare.

Uganda is expected to potentially benefit from the expanded East African Common Market[10], through unrestricted movement of labor, capital, and other goods and services within the common market. However, trade with the largest economies in the region (Kenya and Tanzania) has been one sided, with limited exports from Uganda to her two trading partners. Uganda‘s trade has been boosted mainly by trading with post conflict economies which include: The Republic of Southern Sudan, the Democratic Republic of Congo (DRC), Burundi, and Rwanda (Ssewanyana, *et al*., 2010). As regional markets expand, the onus is on Uganda to take advantage of her comparative advantage in food production. There is need to increase food production and investment in agro-processing industries to increase value addition and exports so as meet increasing demand in regional as well as world markets.

2.5 Impact of Growth on Poverty Reduction in Uganda

2.5.1 Poverty Head Count and Inequality Trends

Uganda, unlike other African economies, was the first country to achieve the first Millennium Development Goal of halving extreme poverty before 2015. Because of broad based growth, the proportion of the population living below the poverty line declined from 56 percent in 1992/1993, to 44 percent in 1997/1998, to 31.1 percent in 2005/2006, and to 24.5 percent in 2009/2010 (Poverty Reduction Strategy Paper, 2010). The absolute number of poor people declined only marginally from 9.8 million in 1992 to 8.4 million in 2005/2006 and to 7.5 million in 2009/2010. It should be noted that poverty in Uganda is predominantly a rural phenomenon and that majority of the poor live in rural areas (Uganda Bureau of Statistics, 2010).

Despite the decline in the poverty headcount[11] over the last 2 decades, Uganda experienced worsening income inequality. The computed Gini coefficient

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[10] A regional market comprising of Kenya, Uganda, Tanzania, Rwanda, Republic of South Sudan and Burundi, with population of 133 million people.

[11] Poverty head count is the percentage of people estimated to be living in households with real private consumption per adult equivalent below the poverty line for their region.

was 0.365 in 1992/1993, 0.408 in 2005/2006, and this increased to 0.426 in 2009/2010 (Table 2.5.1).

Table 2.5.1 Gini Coefficient Estimates, 1992/1993-2009/2010

	1992/1993	1999/2000	2002/2003	2005/2006	2009/2010
National	0.365	0.40	0.43	0.408	0.426
Rural	0.330	0.33	0.36	0.363	0.375
Urban	0.40	0.43	0.48	0.432	0.447
Central	0.395		0.46	0.417	0.451
Eastern	0.327		0.37	0.354	0.319
Northern	0.345		0.35	0.331	0.367
Western	0.319		0.36	0.342	0.375

Source: Ssewanyana and Okidi 2007.

Meanwhile, between 1997 and 2000 consumption expenditure per adult equivalent for the richest 10 percent of the population grew by 20 percent while that of the poorest 10 percent grew by only 8 percent. This was associated with an increase in the Gini coefficient from 0.35 to 0.4. During the period 2000/2003, the richest 20 percent experienced a 9 percent increase in consumption expenditure while the reminder of the population experienced a decline in their consumption expenditure (Okidi *et al.*, 2007). The increase in inequality was accompanied by the increase in the poverty headcount in most regions of the country between 1999 and 2003 (Table 2.5.2).

Table 2.5.2 Poverty Headcount (%) in Uganda, 1992/1993-2009/2011

	National	Rural	Urban	Central	Eastern	Northern	Western
1992/1993	55.7	59.7	27.8	45.6	58.8	72.2	53.1
1995/1997	45	49.2	16.7	27.8	54.3	60.9	42.8
1999/2000	33.8	37.4	9.6	19.7	35	63.6	26.2
2002/2003	37.7	41.7	12.2	22.3	46	63.3	31.4
2005/2006	31.1	34.2	13.7	16.4	35.9	60.7	21.8
2009/2010	24.5	27.2	9.1	10.7	24.3	46.2	21.8

Source: Ssewanyana and Okidi 2007.

The increase in inequality between 1999/2000 and 2002/2003 was accompanied by the increase in poverty headcount from 34 percent to 38 percent during the same period (Table 2.5.2). In addition, income inequality between rural and urban areas and between regions increased between 2005/2006 and 2009/2010 (Ssewanyana *et al.*, 2007). During this period, Uganda's economy attained a substantial increase in real GDP growth averaging 7.2 percent per annum (World Development Indicators, 2010). The increase in inequality on one hand, and the increase in real GDP on the other during this period, perhaps suggests that the benefits of growth did not trickle down to the most vulnerable groups especially the rural poor. Although studies have shown that growth is good for the poor (Dollar and Kray, 2001), this has not been the case for Uganda. It is important to note that income inequality retards the pace of poverty reduction, because, keeping other factors constant, high or increasing inequality reduces the benefits of growth that accrue to the poor. High inequality may also make it more difficult to attain and sustain economic growth (Ssewanyana, 2009). It has been suggested that Uganda's economy should grow by at least 7 percent per annum and household consumption should increase by at least 4 percent per annum if the economy is to avoid reversals in its poverty reduction efforts (Ssewanyana *et al*., 2010).

Meanwhile, the increase in the poverty headcount regionally between 1999/2000 and 2005/2006 happened at a time when the government was pursuing pro-poor polices but with limited or no participation of the poor in the growth process. This implies that the increase in inequality could have been caused by concentration of income and employment opportunities in the hands of few firms and rich business owners whose share in real private consumption expenditure accounted for three quarters of real GDP growth (Ssewanyana, 2010) during this period. For growth to contribute to poverty alleviation, it should take place in regions or sectors where majority of the poor participate. For Uganda, this requires the identification of key sectors with strong linkages to the rest of the economy. This dissertation among other things is intended to identify key sectors that could significantly contribute to growth and poverty alleviation in Uganda.

Overall, the poverty gap[12] (2.5.3) declined faster than the poverty headcount (Table 2.5.2), suggesting an increase in mean consumption by the poor (Ssewanyana and Okidi, 2007).

Table 2.5.3 Poverty Gap, 1992/1993-2009/2010

	1992/1993	2002/2003	2005/2006	2009/2010
National	20.9	11.9	8.7	6.8
Rural	22.6	13.1	9.7	7.6
Urban	8.7	3.9	3.5	1.8
Central	15.3	5.5	3.6	2.4
Eastern	22	14.1	9.1	5.8
Northern	30.3	23.4	20.7	15.5
Western	18.7	8.5	5.1	5.4

Source: Ssewanyana and Okidi 2007.

The recovery in the agricultural sector, especially the food crop subsector and the return to peace and resettlement of internally displaced people in northern and eastern Uganda partly contributed to the decline in poverty between 2005/2006 and 2009/2010. It has been suggested that the high GDP growth rates between 1992/1993 and 2009/2000 were solely responsible for the large reductions in poverty other than offsetting the increase in inequality (Ssewanyana *et al*., 2007). Between 1999/2000 and 2002/2003, there was a reversal in national as well as regional poverty trends. Growth was confined to the richest 20 percent of the population and the increase in rural and urban poverty was largely due to increasing income inequality (Okidi *et al*., 2004).

2.6 The Role of Migrant Remittances

Remittances are foreign exchange earnings directly transferred by Ugandans living and working abroad to Ugandan households (Table 2.6.1).

[12] Poverty gap is the mean shortfall from the poverty line (counting the non-poor as having zero shortfall), expressed as a percentage of the poverty line. This measure reflects the depth of poverty as well as its incidence (World Bank).

Table 2.6.1 Remittances and Share of Remittances in GDP (%), 2001/2002-2010/2011

Financial Year	Remittances (US$ million)	Remittances (as % of GDP)
2001/2002	438	3.8
2002/2003	310	6.0
2003/2004	289	6.8
2004/2005	316	4.7
2005/2006	441	3.7
2006/2007	325	3.6
2007/2008	546	4.1
2008/2009	897	3.8
2009/2010	851	5.0
2010/2011	972	4.7

Source: Bank of Ugandan (BOU) Annual Reports 2010/2011.

Remittances play a significant role in improving the welfare of households and thus support government policies that target poverty alleviation. In its recent report on migrant workers remittances[13] to developing countries, the World Bank highlights that transfers are directly received by households and are used to finance education, savings and investment, housing, and meeting the cost food and other expenses. According to World Bank and Bank of Uganda estimates, households received US$851 million (UGX 1.7 trillion) in 2009/2010. This was US$46 less than the US$897 million (UGX 1.8 trillion)[14] received in 2008/2009. It is worth mentioning that workers remittances surpassed the value of Uganda's key traditional and non-traditional exports such as tourism, coffee, and fish exports which generated US$400 million (UGX 900 billion), US$269 million (UGX 605 billion), and US$143.5 million (UGX 323 billion) in 2009/2010 respectively. To emphasize the importance of workers remittances, the decline in Uganda's real GDP growth from 7.1 percent in 2008/2009 to 5.8 percent in 2009/2010 was partly due to falling remittances as a result of the global financial crisis that affected employment and earnings of Ugandans living and working abroad (Bank of Uganda Annual Report, 2009/2010**).** To analyse the economy wide effects of a shock to remittances on

[13] Migrant Remittances Fact Book, 2010/2011. The World Bank Group, Washington, D.C. Available on
http://siteresources.worldbank.org/INTLAC/Resources/Factbook2011-Ebook.pdf

[14] UGX = Uganda shilling, the local currency.

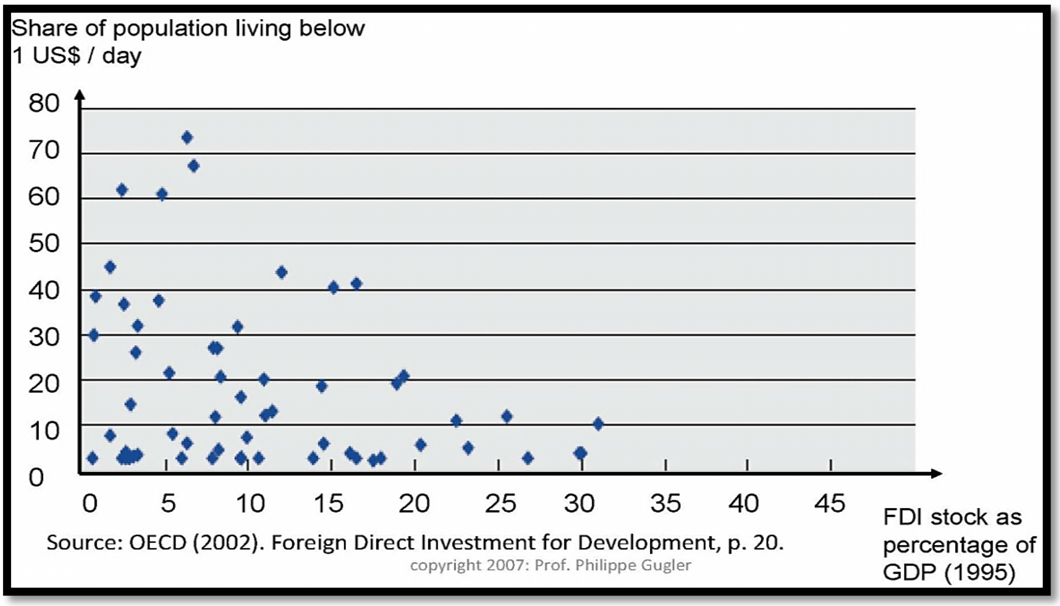
Uganda’s economy, a simulation experiment was designed and performed in the CGE model for Uganda (see Chapter 7).

2.7 Foreign Savings and Poverty Alleviation in Uganda

Net capital inflows into the economy which are in form of foreign aid or private financial flows can finance productive investments in the private and public sector and thus create addition real incomes in the long-run. The raise in real incomes stimulates increased household consumption, which in turn increases the production of goods and services for the domestic market and exports hence leading to economic growth (Chenery and Strout, 1966). Generally, foreign direct investment is used to finance infrastructure projects (i.e. roads, schools, and hospitals) which are vital in supporting government programs for growth and poverty alleviation (IMF-Poverty Reduction Strategy Paper, May 2010).

The benefits of FDI in developing economies are well documented. Given the appropriate host-country policies and a basic level of development, a number of studies have shown that FDI triggers technology spill overs, assists human capital formation, contributes to international trade integration, helps create a more competitive business environment, and enhances enterprise development. All of these contribute to higher economic growth, which is the most potent tool for alleviating poverty in developing countries (OECD, 2002). In addition, it has been found that as the share of FDI in GDP for recipient economies increases, the proportion of people living below the poverty line in developing economies decreases (Figure 2.7.1).

Figure 2.7.1 FDI (as % of GDP) and Poverty in 60 Developing Countries

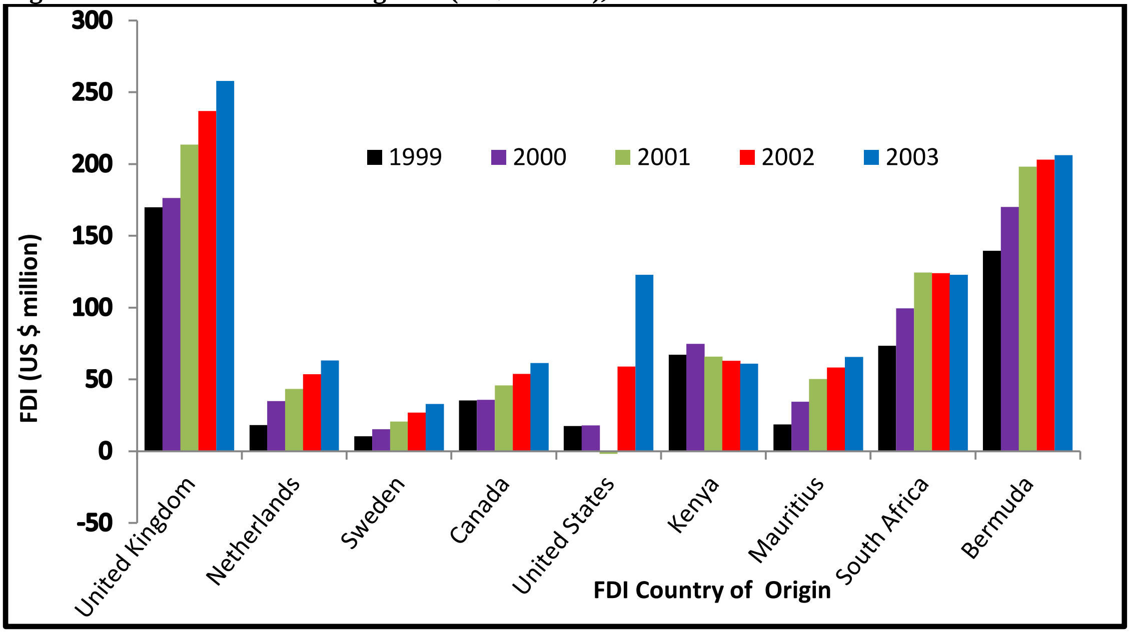


Source: OECD, 2002.

FDI is the main form of foreign savings in Uganda. The United Kingdom is the leading origin of FDI, followed by Bermuda and South Africa (Figure 2.7.2). The distribution of FDI by sector suggests that manufacturing, other services (finance, insurance, banking and telecommunications) attracted large FDI inflows between 1999 and 2003 (Figure 2.7.3). FDI into the service sector accounted for 38 percent of the total in 1999, and by the end of 2001 the share of FDI into services had risen to 52 percent.

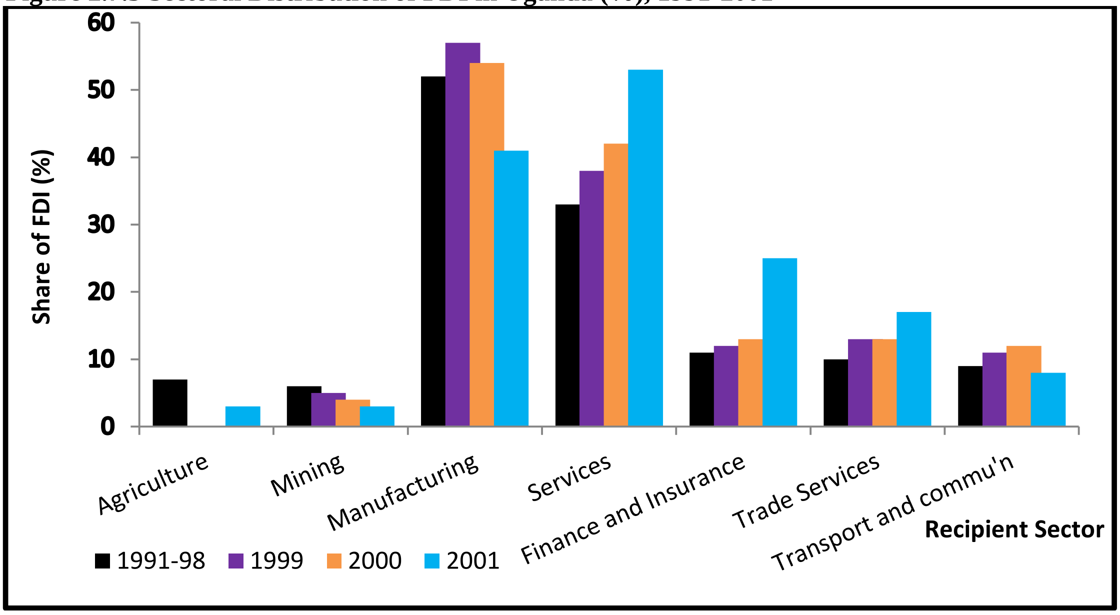
The sale of Uganda's largest commercial bank, the strategic investment of global banks such as Citibank and Stanbic Bank in emerging markets, and opening up of competition in the telecommunications sector boosted the growth of the services sector. Growth in telecommunications was characterized by significant investments in mobile phone facilities in many parts of the country, led by South African based Mobile Telecommunications Network (MTN). According to Uganda Investment Authority (UIA), Uganda will become a major destination of FDI when the country's nascent oil and gas sector becomes fully operational (i.e. with production and refining of oil products expected to commence in 2017). The economy wide effects of a shock to foreign savings are discussed in Chapter 7.

Figure 2.7.2 Sources of FDI in Uganda (US$ million), 1999-2003



Source: World Investment Report, WIR 2003.

Figure 2.7.3 Sectoral Distribution of FDI in Uganda (%), 1991-2001



Source: Obwona (2001).

2.8 Key Challenges and Reforms for Growth

2.8.1 Reforms to Accelerate Growth

Uganda has experienced rapid economic transformation in the last two decades (1990-2010). This economic transformation is attributed to prudent policies that aimed at macroeconomic stability by keeping low inflation and maintaining output growth (Ssewanyana *et al.*, 2010). In fact the World Bank recognized Uganda's economic growth achievement and stated that the country's efforts are the most far reaching stabilization and structural reform program, and one of the most comprehensive reform efforts in the world (World Bank, Country Brief 2010; World Bank 2007, p.4). Uganda adopted the Economic Recovery Program (ERP) as its first reform in 1987, with support from the World Bank and the International Monetary Fund (IMF). The ERP focused on economic liberalisation and stabilisation and was comprised of currency reform, devaluation, liberalisation of domestic prices and the shift to a flexible exchange rate regime in 1993. The ERP was accompanied by the structural adjustment programs (SAPs). The adjustment programs were meant to free the markets and create price incentives, promote private investment and encourage competition. These structural programs included: the abolition of marketing boards, the privatization and sale of public enterprises, and the establishment of the Uganda Investment Authority (UIA). During this period, Uganda experienced sustained macroeconomic stabilization and adjustment, and structural reform efforts that affected almost all sectors of the economy. Policies mainly involved macroeconomic stabilization, price liberalization, financial sector liberalization, public enterprises reform and civil service sector reforms. In addition to stabilization of the economy, efforts were directed at reorientation of the pricing system and marketing policies, restarting economic growth and strengthening of institutions. To achieve these goals, the Economic Recovery Program focused on ensuring macroeconomic stability; liberalising the foreign exchange system, price stability and marketing systems; improving the incentive structure and business climate to promote savings mobilization and investment; and rehabilitating the economic, social, and institutional infrastructure.

With the economy growing again in 1997, the government focused on poverty eradication by introducing the Poverty Eradication Action Plan (PEAP), a multi-sectoral program aimed at reducing poverty. The PEAP comprised of the Plan for the Modernization of Agriculture (PMA), which was aimed at addressing agricultural constraints to production and making agriculture commercially viable. The plan was not as successful as early thought, mainly because it was too broad and in some cases ambiguous, with many programs and targets when the focus should have been on increasing agriculture productivity. In fact, the National Agricultural Advisory Services (NAADS), a subset program within the PMA meant for increasing agricultural productivity was characterized by inefficiency problems which limited its full impact on the agriculture sector. Other strategic interventions that aimed at stabilizing macroeconomic activity and growth in Uganda include: the Medium-Term Competitive Strategy for the Private Sector (MTCS), the Strategic Export Program (STRATEX), and the Strategic Export Intervention Program (SEIP). Strategic reforms to improve efficiency in service delivery came into force. These included: decentralization, shutting down of marketing boards, and the restructuring of public administration through the Public Enterprise Reform Divesture (PERD).

2.8.2 Challenges to Sustainable Growth and Poverty Reduction

A number of challenges will need to be addressed if Uganda is to reduce absolute poverty to below 20 percent by 2015. However, to achieve this, growth has to be maintained at 7 percent per year (Ssewanyana *et al*., 2010). Key among the challenges to poverty reduction and sustainable growth include:

(a) Reducing Poverty and Slowing Population Growth

According to the World Bank, if Uganda's economy grows at 7 percent per annum as in the 1990s, it will take Uganda 20 years to double her average per capita income. In addition, Uganda has one of the highest population growth rates in the world at 3.5 percent per annum compared to a world average of 1.2 percent. According to the World Bank, the high population growth rate will make it difficult to reduce poverty (World Bank, 2007). High population growth has slowed down the pace of economic growth given that Uganda has to use the limited resources to increase the provision of social services, implying that critical sectors like Agriculture are likely to get inadequate funding. The emphasis should be spending on programs that are geared towards reducing population growth. If population growth is not checked, it will be hard to achieve most of the Millennium Development Goals. It has also been suggested that achieving and sustaining agriculture sector growth (i.e. by increasing production and productivity) is the most effective way of alleviating poverty and improving the livelihoods of rural and urban households while sustaining economic growth (PRSP, 2010/2011-2014/2015).

(b) Low Productivity Growth and Transformation in the Agriculture Sector

Output growth in the agriculture sector has remained low relative to the service and manufacturing sectors. Similarly, agriculture is largely dominated by small scale subsistence farming on small size land plots. In order to increase output, there is need to promote large scale commercial farming and reforming the system of land ownership. Such reforms should encourage the transfer of small plots of land from landlords in rural areas to enable the government plan for commercial agriculture production. The government could also try to draw the rural population to urban centers through more planned urban development. In addition, agriculture productivity is limited by rudimentary production methods where simple farm tools are used to cultivate land; undeveloped value chains, and limited public and private investment in the sector. The Uganda government needs to address the problem of low productivity by creating on-farm and off-farm processing zones to add value to agricultural commodities, increasing farmers’ access to micro-credit to finance production and marketing of agriculture produce; providing inputs to farmers at subsidized prices; reviving cooperatives; initiating resettlement schemes and relocating and adequately compensating owners who cannot make significant investment to increase the value of land; and committing to meaningful land reforms so as to increase agricultural production as stipulated in the country's poverty reduction strategy paper (PRSP, 2010). The overall agriculture development strategy should be integrated within the framework of increased government expenditure on agriculture by increasing the share of the sector in the national budget to 10 percent up from the current average of 4 percent (Thurlow *et al.*, 2008).

(c) Inadequate Infrastructure

The country's physical and social infrastructure is recognized as one among the worst in the world (World Bank 2007; PRSP, 2010). The existing roads, railways, power lines, and financial infrastructure are either inadequate or below international standards. The National Development Plan (NDP) lists the lack of adequate power supply, transport, and the high cost and limited access to credit as the most daunting infrastructural impediments. In addition, weak infrastructure is the key binding constraint limiting growth and productivity in the agriculture sector in Uganda. To address acute power shortages, the government in partnership with the private sector is allocating a significant portion of her recurrent budget to the construction of hydroelectric power dams.

(d) Inadequate Growth of the Private Sector

Private sector led growth has been impressive since the liberalisation period of the 1990s where Uganda recorded an average annual real GDP growth of 6.9 percent (IMF, Country Poverty Reduction Strategy Paper, 2010). Despite private sector participation in economic activities, the economy is dominated by small sized farms that usually employ less than five workers, making it difficult to absorb the growing number of graduates and the youth. Unemployment has been worsened by the high population growth rate. Uganda's population growth rate of 3.3 percent per annum is among the highest in the world (World Bank 2010). In fact, recent estimates put youth unemployment at 83 percent and graduate unemployment at 36 percent (World Development Report, 2007). Most private sector activities are urban-biased and concentrated in the service sector. Within sectors in which the private sector is active, the impact of its activities on employment is very minimal, save for a few high skilled labour categories.

(e) Narrow Export Base and Poor Terms of Trade

Despite the diversification of her export base, Uganda remains heavily dependent on the production and export of primary agriculture commodities. Export diversification is further limited by low value added of primary products, poor quality of processed products, poor regulation standards, which reduce the export competitiveness in regional and global markets. Few exports imply less foreign exchange earnings. In addition, the value of exports is far much less than the value of imports, which has always resulted in poor terms of trade and balance of payment problems.

(f) Limited Fiscal Resources

Tax revenue is inadequate in Uganda. This is partly due to tax evasion, non-taxable sectors such as agriculture and the informal sectors (Matovu *et al*., 2009). Low revenue generation capacity has meant that Uganda has largely depended on foreign aid to implement her socioeconomic programs. Foreign aid accounted for 32 percent of the budget in 2008/2009. In addition, the share of Uganda's tax revenue to GDP of about 13 percent per year is very low compared to her East African neighbors, Kenya (27 percent of) and Tanzania at 17 percent of GDP in 2008/2009 (Ssewanyana *et al*., 2010). Lack of adequate tax revenue limits government ability to implement development programs and weakens economic management. It also increases government borrowing from to finance development programs which increases the future debt burden. The recent discovery of oil in Uganda could significantly increase the resource envelope to finance Uganda‘s development programs. Similarly, the government should try to expand the tax base, by targeting sectors that are currently untaxed especially the informal sector and minimizing tax evasion through strict regulation.

(g) Corruption and Weak Governance

Corruption is one of the key challenges facing Uganda's economy today. A report by the World Bank ranked Uganda among the most corrupt states in the world (World Bank, 2010). The report suggests that Uganda loses about shillings 500 billion annually through procurement malpractices and corruption. The report further argues that corruption has aggravated poverty among Ugandans, hampered service delivery and is rife in many public sectors. Uganda‘s ranking on the Ibrahim Index of African governance improved from 27th in 2007 to 19th in 2008 due to government renewed efforts to fight corruption. But in May 2009, Transparency International ranked Uganda as the third most corrupt country in the world. Although there has been remarkable progress in tax administration, with tax revenue to GDP increasing by 12.5 percent, corruption and other administrative inefficiencies remain the significant obstacles to effective domestic revenue mobilization by Uganda Revenue Authority (Transparency International, 2010).

(h) Weak Human and Institutional Development

The national development plan (NDP, 2010-2015) identifies weak human and institutional development among the key binding constraints that Uganda need to address in order to achieve socioeconomic development. Ministries and other government corporations are characterised by coordination failures, corruption, endemic malaise, and weak institutional linkages among relevant stakeholders, including the Ministry of Finance Planning and Economic Development, sector line ministries, and the private sector. As a result, budgeting processes are inefficient and scarce investment resources are not allocated rationally. Implementation of government programs at local administrative units is characterized by bureaucratic delays and lack of skilled manpower (Ssewanyana *et al*., 2010).

2.9 Conclusion

This chapter discussed the background of Uganda's economy using socioeconomic trends and outcomes of policies so far implemented. Understanding the country's economic background provides a better interpretation of the effects of various policies. The importance of the agriculture sector to Uganda's economy in general, and to households in particular was discussed. The challenges to poverty reduction and growth in Uganda were discussed in detail. Guided by the research questions and Uganda's economic challenges, this study uses an economy wide modeling framework comprising of the social accounting matrix (SAM) multiplier and computable general equilibrium (CGE) model. The justification of our modeling framework, the research questions, and research contribution of this study are discussed in Chapter Three.

Chapter Three

Literature Review and Methodology

3.1 Introduction

Among economy wide models, social accounting matrix (SAM) based computable general equilibrium (CGE) models are preferred to partial equilibrium and other econometric models due to their low data requirement. A social accounting matrix is a single accounting framework with its rows and columns indicating income and expenditure accounts of various economic agents in an economy. The SAM is built on the double entry accounting principle which requires that for each account in the SAM, total incomes equals total expenditures. Its data source includes input output tables, national income statistics, and household income and expenditure statistics. In addition, a social accounting matrix is not only a statistical tool but also a framework for macroeconomic analysis (Thurlow *et al*; 2010). It provides a framework for the organization of information about the socioeconomic system and serves as a base year database for computable general equilibrium models. The SAM is therefore used to prepare multi-sectoral and single country CGE models which are used to conduct economic analyses and policy simulations (Cardenette and Sancho, 2002). Such models permit us to conduct impact analysis of the structure of production and income distribution. This analysis is beneficial to policy makers because they can target specific sectors that have significant impact on output, employment and welfare (i.e. the impact of exogenous changes and policies on the welfare of the poor can shed light on how to implement policies that can alleviate poverty and inequality).

The methodology used in this dissertation is divided into two main sections. First, we identify the key sectors for Uganda by calculating the sectoral linkages using the social accounting matrix multiplier model. Unlike the traditional input-output multipliers which measure the effects of production linkages only, SAM multipliers measure the value of all production and consumption linkages (Thurlow *et al.*, 2010). Consumption linkages arise because an increase in production due to an increase in exogenous demand creates additional incomes for factors and households, which can be used to purchase goods and services. On the other hand, production linkages are determined by a sector's production technologies which are contained in the input-output part of the SAM. These are further classified into forward and backward linkages. The calculated forward and backward linkages are vital in answering one of our key research questions: what are Uganda's key sectors? SAM multipliers are decomposed further to determine the direct (open loop effects); indirect (transfer effects); and total (closed loop) effects of exogenous policy changes**.** The multiplier decomposition is important because it can suggest how well the economy is integrated and therefore does not only look at the aggregate effect of a shock but also the contribution of inter-industry relations and other accounts in the total impact of a shock (Thurlow and Dorosh, 2009; Nganou, 2005**)**. It is worth mentioning that as far as we know the identification of key sectors using the SAM multiplier decomposition technique and their ranking in terms of factor and household income generation, output and employment creation is the first of its kind in Uganda. Thus, our results from the SAM multiplier decomposition and simulations with the CGE model provide the basis for identification of appropriate policies for poverty alleviation and growth in Uganda.

The second part of the methodology is the calibration of the CGE model to the SAM before any policy experiment is performed. Computable General Equilibrium (CGE) models can be defined as multi-sector economy-wide models built specifically with behaviour functions for producers, consumers, and other economic agents (Nganou, 2005). They are a multisectoral model based on one or several national economies and they provide an ideal bridge between economic theory and applied policy research (Bergman, 2003). In addition to providing a detailed record of the degree of interdependency between economic agents within a competitive economy, CGE models capture the allocation of resources to the production process and how this allocation may impact the incomes of factors, households, and other institutions.

Similarly, CGE models are used in economic policy analysis because they can capture the effects of policy changes on the entire socioeconomic system , that is how exogenous variables (e.g. tariffs, world prices, etc.) affect other endogenous variables (e.g. relative prices of output and inputs, sectoral output, institutional incomes, private consumption, welfare, poverty, GDP etc.). This unique feature of examining the impact of exogenous policy changes on a multi-sectoral level has seen a prolific increase in the use of CGE models in analysing policy issues (e.g. trade liberalisation, environmental regulation and climate change, regional integration, etc.). In addition, CGE models are ideal for the analysis of the distributional impact of public policies on the poor. There are useful in conducting poverty and social impact analyses (World Bank, 2011).

Compared to the input-output (I-O) and SAM multiplier models, CGE models capture the interdependency between sectors and other institutions (i.e. households, government and the rest of the world). CGE models differ from SAM multiplier models because they are represented by a series of behavioural functions, most of which are non-linear equations, capturing all transactions in the SAM (Lofgren *et al*., 2002). Even though some economists have labeled CGE models as a “black box” capable of producing any solution, the theoretical foundation of these models helps to trace back the simulation results and to explain which factors are important in explaining these outcomes. In addition, CGE models are explicitly structural and do not encounter the identification problem as in partial equilibrium models. In CGE models, economic agents (i.e. consumers and producers) are assumed to maximize their objective functions and that all markets clear and prices are flexible. It is important to note that the CGE model for Uganda is an extension of the modeling framework developed by the International Food Policy Research Institute (Lofgren *et al*., 2002) under the neoclassical tradition in which all markets clear (Dervis, *et al*., 1982).

In the next section, the methodology adopted in answering the specific research questions is discussed. A review of the literature on SAM multiplier and CGE models and their applicability to developing countries presented in this section. Research questions and the significance or contribution of this dissertation are also discussed.

3.2 Methodology

The methodology used in this dissertation is guided by the research questions that we set to address. In general, we are interested in evaluating the impact of exogenous shocks on Uganda’s economy. This kind of analyses requires general equilibrium analysis as opposed to a partial equilibrium analysis. This is because we are interested in the general equilibrium feedback effects that arise when an economy is exposed to an exogenous shock. In addition, inter-sectoral linkages are complex to be analysed in a partial equilibrium set up. With data availability, applied general equilibrium analysis is performed on a system of linear and non-linear equations using econometric tools (Jorgenson 1984). These equations specify the technology and consumption behavior of households, and other institutions in a given economy. Conducting this kind of analyses is limited in developing and some developed countries because of lack of time series data. To solve the data requirement problem, static input-output and SAM based computable general equilibrium models are used.

Unlike econometric models, computable general equilibrium models require a single year of data (i.e. base year) for inter-sectoral linkages and policy effects to be analysed. With such models, the input-output table or social accounting matrix acts as the data base. Static general equilibrium models can be used to evaluate the effects of external shocks on endogenous accounts which represent sector outputs, factor payments, institutional incomes, intermediate demand, welfare etc.). To measure the effect of the shock on an endogenous variable, the post shock values are compared with base year values.

As explained earlier, this dissertation applies the SAM multiplier model to identify Uganda's key sectors and to evaluate the country's prospects for poverty alleviation and growth prospects arising from a series of selected exogenous changes and policy shocks (i.e. we assume that if there is a sudden policy change or shock, which sectors or agents would be most affected and what would be the economy wide effects of the shock on output, employment, factor and household income distribution). Given that the accounts in the SAM are interdependent, the calculated multipliers are decomposed further to capture the causal linkages underlying the structure of the economy. On the other hand, the multiplier decomposition is important in our analysis because it provides more information on how well Uganda's economy is integrated and this is important for the selection of potential sectors for growth and poverty alleviation.

The decomposed multipliers can also be used to evaluate the contribution of inter-industry relations and other accounts in the total impact of the shock (Nganou, 2005). It should be noted that the SAM multiplier model is limited in its analysis of supply side shocks. To account for this limitation, this dissertation is extended to incorporate supply side shocks (e.g., effect of trade liberalization) using a computable general equilibrium model. In the sections below, we discuss the limitations of SAM multiplier models and justify the use of computable general equilibrium models (CGE) in analyzing the effects of exogenous changes and policies.

3.2.1 Economy Wide Modeling: SAM vs. CGE Models

Social Accounting and Computable General Equilinbrium models are said to belong to the same family of economywideor general equilibreium models. Generally, the realtuonship can easily be traced through an algebaric representaion of the impact analysis following Taylor *et al*. (2002). Lets us consider the effect of a change in an exogenous variable, *R* (e.g. an increase in migrant workers' remittances) on an endogenous variable or vector of variables *X*, (e.g output, factor, or household incomes). Let *P* represent a vector of local input or ouput prices. The total impact of the change in *X* due to a change in *R* is given by

$$\frac{dX}{dR} = \frac{\partial X}{\partial R} + \frac{\partial X}{\partial P} \cdot \frac{\partial P}{\partial R} \qquad (3.2.1)$$

The first part of on the right hand side of equation (3.2.1) represents the direct income effects. The second term represents the indirect (general equilibrium) effects of the exogenous shock transmitted through endogenous local prices (Taylor *et al*., 2002). According to Taylor, the second term can be ignored if all prices are given to the economy by outside markets (i.e. under the small country assumption and if the supply of all goods and factors is assumed), or the supply of all goods and services is assumed. It is common practice to use SAM multiplier models to analyse the effects of exogenous changes and policies when the tradability of all goods,inputs, and perfect elasticity of supply are assumed.

These models are Keynesian demand based systems because they assume that resources are unconstrained (i.e. there exist excess capacity in all sectors) and perfectly elastic supplies (e.g., unemployment or underemployment of factors). Prices are fixed and any exogenous changes in demand changes physical output rather than prices; production technology and resource endowments are given (i.e., the analysis is necessarily a short-run one and no dynamics of any kind are taken into account; average expenditures propensities of endogenous accounts in the SAM remain constant (i.e., linkage effects are linear and there is no behavioral change, and no input substitution). In general, SAM multiplier models are used to estimate the impact of exogenous changes in the demand block i.e., changes in exports, government expenditure on factor demands, output, and institutional income distribution (Thurlow *et al*., 2009).

3.2.2 Choice of CGE Models: Justification for their Use in Policy Modeling

Meanwhile if goods and services are non-tradable and their supply is not perfectly elastic, then the value of the indirect or general equilibrium effect in equation (3.2.1) above may not be zero. To capture this effect, it would necessitate the use of computable general equilibrium models (CGE) since these models take into account resource constraints, non-linearities, and changes in input and output prices into an economy-wide modeling framework (Nganou, 2005). Dixon (2006) summarizes the basic features of CGE models as follows: They produce numerical results (i.e. there are computable). They include explicit specifications of the behavior of several economic actors (i.e. they are general). The objective of households is that of utility maximization and that of producers is profit maximization or cost minimisation. Through the use of such optimizing assumptions, CGE models emphasize the role of commodity and factor prices in influencing consumption and production decisions by households and producers. Included in these models are the optimising behaviours of governments, trade unions, importers and exporters. The coefficients and parameters in various equations of CGE models are evaluated by referring to a numerical data base (i.e. a set of input-output accounts or the SAM).

The input-output and SAM data are usually supported by numerical estimates of elasticity parameters (e.g. elasticities of substitution between imports and domestic goods, between exports and domestic goods, and between factors of production). Computable general equilibrium models are an improvement on the SAM multiplier models. In our analysis, a SAM based CGE model for Uganda is developed along the lines of the IFPRI standard model (Lofgren *et al*., 2002) to estimate the effects of selected exogenous changes and policy shocks.

3.2.3 SAM Multiplier and CGE Models for Uganda

Uganda, like any other developing country has elements of external regional and international economic dependency. In fact, the economy depends heavily on exports of agriculture raw materials mainly coffee and other traditional (e.g. Cotton, Tea, and Tobacco) and non-traditional exports (i.e. fish, maize, cut flowers, beans, etc.). Primary exports account for over 75 percent of total foreign exchange earnings (Uganda Human Development Report, 2007). On the other hand, Uganda imports high valued manufactured goods (e.g. heavy equipment, drugs, chemicals, petroleum, etc.). Uganda imports goods and services whose prices are fixed by the world market (i.e. Uganda is modeled as a small country with respect to foreign trade). Given this dependency on fixed commodity prices, the SAM multiplier model or fixed price model would be ideal to analyse the impact of exogenous changes and policies on the socioeconomic system. Similarly, SAM multiplier models are suitable for the identification of key sectors of the economy. Compared to the traditional input-output models which capture production linkages only, SAM multipliers models capture both production and consumption linkages (Chapter 5). Consumption linkages arise when the expansion of production generates additional incomes for factors and households, which are then used to purchase goods and services. For example, when agricultural production expands, it raises farmers' incomes which are used to purchase consumer goods which stimulate further agricultural production.

In decomposing SAM multipliers, three different effects are captured. These are: transfer (within account) effects, which capture the inter-industry or input-output relationships among various production activities or any interdependence originating from the pattern of transfers of income between households, and the spillover or open-loop effects which capture the effect of the shock on other endogenous accounts (i.e. factor and household income accounts) when a set of accounts, say activities is affected by an exogenous shock, and the shock does not return to the origin or source account (i.e. there are no reverse effects). Feedback or closed loop or between account effects, capture the full or total impact of the shock after the exogenous shock has completed the circular flow of income and returned to the origin or source account (Pyatt and Round 1985). The multiplier decomposition presented in this dissertation was proposed by Pyatt and Round (1979). It is important to note that the use of the multiplier decomposition technique to identify key sectors and to estimate the economy wide effects of exogenous shocks and policies is the first of its kind in Uganda. A detailed description of the SAM multiplier decomposition is presented in Chapter 5.

Note that the SAM multiplier model is not without limitations. These include: lack of input substitution, linearity in technology, perfect elasticity of supply, and fixed prices. To overcome these limitations, a specific single country CGE model is developed along the lines of the CGE model proposed by the International Food Policy Research Centre (Lofgren *et al*., 2002). The model is calibrated to the basic features of Uganda's economy.

The CGE model for Uganda follows the neoclassical tradition in which all markets are assumed to clear (Dervis *et al*., 1982). This model is flexible enough to accommodate the selected exogenous shocks and the research questions proposed in this dissertation. In order to obtain equilibrium in CGE models, factor and macro closures are assumed. The choice of closures is driven by the fact that CGE models have more variables than equations. Solving such models mathematically requires making a right choice about endogenous and exogenous variables, and making sure that the number of equations is equal to the number of variables. A review of closure rules (Sen 1963; and Taylor and Lysy, 1979) found to a large extent that the choice and type of closure rules affected policy simulation results produced by CGE models.

Economically speaking, "closure" means making sure that the number of exogenous variables are selected in such a way that the economic situation in which the policy shock is tested best reflects the true economic environment in which the policy shock is examined. In addition, the choice of a particular closure rule is governed by two factors: First, the time frame under which economic variables are allowed to adjust to a new equilibrium (i.e. short-run vs. long-run equilibrium analysis), and secondly, the particular hypothesis to be tested within the simulation and the viewpoint of the modeler on those variables deemed exogenous to the model. A detailed description and choice of closure rules is provided in Chapter 6 and appendix B.

For the balance of payment account, we choose between two closure rules namely: the exchange rate is fixed and foreign savings is allowed to vary to clear the surplus or deficit on the current account. Similarly, foreign savings is fixed and the exchange rate is allowed to vary to clear the deficit or surplus on the current account. With regard to savings-investment balance, there are two possible closure rules: The savings is investment-driven in which investment is fixed and choice is made of those institutions whose savings must adjust to finance investment; and second, investment is savings-driven (i.e. investment is allowed to vary to finance any changes in savings). Government consumption expenditure is fixed in real terms. For more details on the choice of closure and their policy implications, refer to Chapter 6.

For the factor market, closure rules are chosen in such a way that their policy implications truly reflect the nature of factor markets in most developing countries, Uganda inclusive. First, unskilled, semi-skilled and low skilled labour is assumed to be unemployed and fully mobile. This closure rule is based on the fact that, Uganda like any developing country has surplus labour (unemployment). Allowing mobility of low skilled labour which constitutes the largest share of Uganda's labour force could reveal exogenous changes and policies which increase employment and factor incomes, and improve the welfare of households in Uganda. For capital and high skilled labour, full employment/flexible wages closure rule is assumed. This closure rule is adopted due to the shortage of skills in most developing countries, Uganda inclusive (Thurlow *et al*., 2009). The full employment closure ignores the fact that some high skilled Ugandans are unemployed and that there is no immigration. However, Uganda is a member of the East African Community (EAC)[15], and when the East African Union/Federation is fully operational, this will increase mobility of Uganda's labour force to seek employment in other member states.

It is also possible to have a segmented market in which certain types of capital are employed only in certain sectors/activities (that is capital is fixed in activities). Each sector or activity employs an observed base year quantity of capital (i.e. capital is activity specific). This closure is suitable for short-run analysis and when there are significant quality differences between factor units used in different sectors (Lofgren *et al*., 2002).

[15] East African Union (EAU): A regional grouping comprising of Uganda, Kenya, Tanzania, Rwanda and Burundi

The IFPRI standard model requires that social accounting matrices be prepared in such a way that there are no payments from government to factors. However, such payments can be channeled through another account of the activity block. The social accounting matrix used in this dissertation does not have entries from the government account to the factors block. There are other challenges encountered in adopting the CGE modeling framework developed by IFPRI. These include: adjusting the specific country data (i.e. the SAM) in a manner that fits the modeling framework, and, maintaining the specific features of the modeled economy and the consistency in the national accounting framework (Thurlow *et al*., 2002).

In its treatment of foreign trade, the CGE model for Uganda models imports and domestically produced goods as imperfect substitutes. This is what is commonly known as the Armington assumption (Armington, 1969). Under this assumption, goods produced domestically are combined with imports using a constant elasticity of substitution (CES) function. The resulting composite good is the final consumption of domestic institutions and consumption of intermediates by activities (Lofgren *et al*., 2002). The Armington assumption is relevant to Uganda because of the high volume of interregional trade involving differentiated products. For example, Uganda exports and imports textiles and food stuffs (mostly cereals) from Kenya just as Kenya does the same from Uganda. In addition, the model distinguishes between domestically produced goods and exports by adopting a downward-sloping, constant elasticity of transformation (CET) export demand curve.

3.2.4 Growth, Welfare Measurement, and Inference about Poverty

Even though we do not use the CGE model for Uganda to measure poverty, we infer about the same by evaluating the impact of exogenous changes and policy shocks on those variables deemed relevant for poverty alleviation and growth (i.e. changes in factor employment and household income distribution, among others). This change is computed as the difference between pre-shock and post-shock values of selected variables for poverty alleviation. In addition, we measure the welfare effects of the price changes due to shocks using two measures. These are: the compensating variation in income (CV) which measures the amount of money each household or consumer must be given in order to compensate him or her for the change in prices caused by the shock; and the equivalent variation (EV) which measures the amount of money the household or consumer is willing to pay to avoid the effect of the price change. To a policy maker, EV is a better measure of welfare than the CV because the change in income or expenditure due to the shock is measured at current prices (Nganou, 2005; Varian, 1992). Our computed welfare measures (as a percentage of GDP) are based on real household expenditure and not on household income because household income includes savings which are meant for future consumption (see Chapter 8).

The analysis of the prospects for growth and poverty reduction is based on the macroeconomic and microeconomic effects of selected exogenous changes and policy shocks. Exogenous changes include: a) a 30 percent increase in the world price of exported commodities; b) a 50 percent increase in migrant workers remittances (i.e. transfers from the rest of the world to Ugandan households). Experiments with the CGE model include: include: a 50 percent decrease in import tariff rates; and d) a 40 percent increase in foreign borrowing or foreign savings. The detailed description of these experiments is provided in Chapter 7.

3.3 A Review of the Literature

SAM multiplier and CGE models have been widely applied to study the impact of exogenous changes and policy shocks in developing and developed economies. For most developing countries, these models have been used to analyse the distributional impacts of various polices, including those that this study seeks to address. In this dissertation our primary objective is to use the SAM-CGE modeling framework to identify key sectors for Uganda, and to analyse the effects of selected exogenous changes and policies on the welfare of different household groups and regions, and the impact on sectoral output and employment. As far as we know, the use of the SAM multiplier decomposition to identify key sectors for Uganda has never been performed before in any analyses in Uganda. In addition, the sectoral effects of increased migrant remittances, and the impact of exogenous changes and policies on employment of different labour types have never been analysed in any CGE analyses in Uganda. Identifying policies that increases welfare, employment, and the sectors associated with higher employment prospects is very important for poverty alleviation In Uganda. The World Bank identifies employment as the surest and most effective way to alleviating poverty in developing countries (World Bank, 2011).

The literature review presented below is concerned with the various applications of SAM based CGE models to address policy issues of growth, income distribution, welfare, and poverty alleviation in developing countries, Uganda inclusive.

3.3.1 SAM Multiplier Models

SAM multiplier models are an extension of the classic Leontief input-output model. Whereas the Leontief model is based on inter-industry production linkages, (i.e. input and output demands between production sectors), the SAM multipliers capture both production and consumption linkages. Consumption linkages arise when an expansion of production generates additional incomes for factors and institutions (i.e. households, firms and government), which are then used to purchase goods and services (Thurlow *et al*., 2009). The use and development of social accounting matrices (SAMs) as a tool in economic policy analysis dates back to the seminal work of Leontief on national income accounts (Leontief, 1941). Further improvements in developing the SAM involved reconciling the system of national accounts in a logical manner (Stone *et al*., 1941; and Stone 1947). Shoven and Whalley (1973) used the SAM to study the general equilibrium effects of policy changes (i.e. changes in taxes). However, the pioneering work by Stone (1978) in reconciling the system of national accounts together with the input-output table gave way to the development and use of the SAM as a framework for policy analysis. What followed thereafter, was the extensive application of SAM multiplier models in analysing a wide range of policy issues e.g. from macroeconomic shocks to growth, poverty alleviation, trade policy and agricultural reforms (Thorbecke and Jung, 1996; Pyatt and Round 1985; Haggblade and Hazell 1989; Bautista 2001; and Diao *et al*., 2007). SAM models have particularly been used to study growth strategies in developing countries (Pyatt and Round 1985; Robinson 1989); income distribution and redistribution (Pyatt and Roe 1977; Adelman and Robinson 1978; Roland-Holst and Sancho, 1992); and fiscal policies (Whalley and Hillaire, 1987); and the decomposition of multipliers that better explain the circular flow of incomes (Stone 1981; Pyatt and Round, 1979; Defourney and Thorbecke, 1984; Robinson and Roland-Holst, 1988).

3.3.2 SAM Multiplier Models: Selected Studies in Developing Countries

Social accounting multiplier models have been widely used to as a tool for economic policy analysis**.** First, Adelman and Taylor (1990) developed what is popularly known as a village-wide economic model[16] for Kenya, Mexico, Indonesia, India, and Senegal and used it to analyse the effects of adjustment policies. In their analysis, they explained how survey data is used to construct the village SAM, and how the SAM can be used to capture village linkages. Finally, they used the SAM

[16] Also known as the village SAM and CGE model

multiplier and CGE models to analyse the impact of exogenous shocks and their distributional effects in selected villages. They concluded that market interactions within villages are essential in generating local income linkages and general equilibrium feedbacks which are often ignored by microeconomic models of household behaviour.

Thorbecke and Jung (1996) developed a SAM multiplier model to analyse the impact of various production activities on poverty alleviation in Indonesia. They concluded that growth in agricultural and service sectors contributed more to poverty alleviation than growth in the manufacturing sector. Along the same lines, Khan (1999) applied the SAM multiplier model to analyse the impact of growth on poverty alleviation in South Africa. He concluded that growth in agriculture, services, and some manufacturing sectors significantly reduced poverty among black South Africans. Similarly, Thorbecke and Jung (1996) and Thurlow and Wobst (2006) explored the link between sectoral growth and poverty alleviation in Zambia. They found that growth in agriculture reduced poverty compared to growth in urban based mining and manufacturing sectors.

Along the same lines as Thorbecke and Jung (1996), Tarp, Jensen, and Arndt (1998) used the SAM multiplier model to examine the relative importance of production sectors in Mozambique. Similarly, Robinson *et al*., (1999) used the SAM based CGE model to identify alternative development strategies for Indonesia. Robinson and his associates acknowledged the limitations of the SAM multiplier model (i.e. linearity in technology, fixed prices, unconstrained resources and no substitution) and extended their analysis by using a SAM based CGE model. By using identical policy experiments, their SAM and CGE models pointed to the fact that agriculture led industrialization resulted into larger increases in real GDP compared to other forms of industrialisation. The authors acknowledged that both models when subjected to identical simulations for a particular economy may produce results that point in the same direction but the magnitude of the effects might be different.

Thorbecke (2000) explained how the SAM can be used as a model and a data base. His attempt was an improvement on earlier work by Thorbecke and Defourney (1984). He argued that in order for the SAM to be used as a model, its accounts must be separated into endogenous and exogenous accounts. His multiplier decomposition analysis was based on the structural path analysis. His argument is that although SAM multipliers can capture global effects of injections from exogenous variables to endogenous variables, they however fail to account for the structural and behavioural mechanisms that generate these global effects. From a policy standpoint, Thorbecke (2000) argued that it is important to not look at the magnitude of the multipliers only but also to account for the structural path analysis that identified the various paths a particular shock travelled (i.e. the direct, indirect and closed loop effects of a given injection).

Unlike Thorbecke and Jung (1996), Pyatt and Round (2006) used the SAM multiplier model to estimate the effects of sectoral growth on poverty alleviation in Indonesia. They found out that the largest poverty alleviation effects were associated with growth in building and construction, mining, and other crop sectors respectively. In addition, Pieters (2010) used the 2002/2003 extended SAM for India to study the effects of sectoral growth on inequality. His findings suggest that growth in several sectors increased the magnitude of between and within household group inequality. However, the effect of growth on inequality was higher in the service sectors (i.e. community, social, and personal services) and heavy manufacturing, and lower in the agricultural sector.

3.4 General Equilibrium Models: Background and Conceptual Framework

A general equilibrium model is a logical representation of a socioeconomic system in which the behaviour of agents is compatible (Essama Nssah, 2005). Therefore, the main modeling issues associated with such models are: the identification of the participants; the specification of individual or agents behaviour; the mode of interaction among socioeconomic agents; and the characterisation of compatibility. The basic Walrasian framework serves as the benchmark for most applied general equilibrium models. These models have two types of agents namely: consumers and producers. These can also be referred to as households and firms. The behaviour of each agent is supposed to conform to the optimisation principle which holds that households and firms attempt to implement the most feasible action. Therefore, modeling optimising behaviour entails the following: actions that an economic agent can undertake; the constraints such an agent faces; and the objective function that is used to evaluate such actions (Varian, 1984). The objective of each household is to maximize utility subject to a budget constraint (i.e. each household buys what it can afford). Similarly, the objective of the firm is to maximize profits subject to a set of technological and market constraints.

In order to analyse the effects of policies using applied general equilibrium models, we need to move from the conceptual framework to a computable model. Applied general equilibrium models are normally represented by a system of equations. These equations can be classified as: demand equations from the equilibrium conditions of consumers; supply equations from the equilibrium condition of firms; income equations explaining the income of each agent based on existing prices and quantities exchanged in goods and factor markets, and the equilibrium conditions for all markets. An example of such models is the computable general equilibrium (CGE) model. CGE models can be defined as completely specified models of an economy, or a region, including all production activities, factors, and institutions. These models include the modeling of all markets in which decisions of agents are price responsive and forces of supply and demand equilibrate markets, and macroeconomic balances, such as investment and savings, the current account, and the government budget constraint. These models can be used to analyse among others, the poverty and social impacts of a wide range of policies and exogenous shocks, changes in taxation, subsidies, and public expenditure, trade policies, and changes in the domestic economic and social structure (i.e. changes in asset redistribution, technological change, and human capital formation). CGE models are ideal for policy analysis when the socioeconomic structure, prices, and macroeconomic phenomena all prove relevant for the analysis. CGE models take into account all sectors of the economy, and permit the detailed analysis of direct and indirect effects of exogenous changes and policies (World Bank, 2003).

The supply and demand equations in CGE models are homogenous of degree zero which implies that if commodity and factor prices are multiplied by a factor *k*, equilibrium supply and demand does not change. This condition satisfies the money neutrality condition. The CGE model used in this dissertation can only determine relative prices. The price system is normalized by fixing the numeraire price (i.e. the consumer price index). The model also satisfies the Walras' law because if all economic agents satisfy their budget constraints and all but one of the markets are in equilibrium; the last market should be automatically in equilibrium (Dinwiddy and Teal, 1988). The choice of the functional forms determines the set of structural parameters that are estimated so as to make the model computable.

The data base for CGE models come in the form of social accounting matrices (SAM). The SAM is a snapshot of an economy for a given year providing an analytically integrated data set that reflects various aspects of the economy such as production, consumption, trade, and income distribution etc. Following the double entry book keeping system, the column sum (payments of accounts) and the row sum (income of accounts) contained in the SAM must be equal. This further implies that the SAM satisfies Walras' law because for a matrix of dimension n, if n-1 accounts balance, the last one balances automatically. The applicability of CGE models in policy modeling is presented below.

3.4.1 CGE Models: Their Development and Use in Policy Modeling

The construction and use of applied general equilibrium models gained momentum following work on input-output models (Leontief 1951; 1953). Before the 1960s, these models were built on assumptions of fixed coefficients to represent technology and preferences. Generally, these models were represented by a set of linear equations with constant coefficients. Advancing the work of Leontief, Johansen (1960) successfully developed an applied a general equilibrium model without the assumption of fixed coefficients (Johansen, 1960). Johansen maintained the assumption of fixed coefficients in modeling the demand for intermediate inputs and used linear logarithmic production functions in modeling the substitution between capital and labour, and technical change. Later, Johansen dropped the assumption of fixed coefficients and replaced it with a system of demand equations developed by Frisch (1959). He finally developed a solution of the resulting non-linear general equilibrium model for the growth rate of endogenous variables (e.g. output, prices etc.) based on a simple matrix inversion. His resulting multi-sectoral model was applied to the Norwegian economy (Dervis *et al*., 1982). In addition, the fixed coefficient assumption for modeling the demand for intermediate inputs advanced by Johansen and Leontief is now popular in most general applied equilibrium models (Jorgensen, 1998).

The model developed by Johansen was improved to include algorithms that would allow the resulting model to be solved for all endogenous variables other than the growth rates of output (Dervis *et al*., 1982). Similarly, Scarf developed an algorithm, to compute the statistic equilibrium of a given economy in a competitive environment (Scarf, 1967; Scarf, 1973). In the early and late 1970s, Walrasian CGE models were pioneered by Shoven and Whalley. These were intended to be computational versions of strict general equilibrium models (Shoven and Whalley 1972; 1976; and 1977). These models were purely Walrasian and ignored the role played by money, prices, and nominal exchange rates (i.e. they were real models). In addition, the applicability of these models was limited to developed countries and they could not address specific features of developing economies (e.g. wages and fixed prices). As a result, the mid-1970s culminated into the development of non-Walrasian CGE models that could be implemented in developing countries (Davies, 2003).

3.4.2 CGE Models and Structural Adjustment Policies

Several studies have applied CGE models to evaluate the impact of structural adjustment policies. Thorbecke (2000) analysed the impact of adjustment programs in Sub-Saharan Africa and Asia. Using country level data, he found that the trend of poverty reduction remained unchanged in Asia until the 1997 Asian Financial Crisis. In Su-Saharan Africa, he found that some countries had slight improvements in poverty reduction while others experienced increases in various poverty measures (i.e. the poverty head count, poverty gap and poverty gap square). Bourguignon, De Melo, and Suwa (1991) used a micro-macro modeling framework combining the explicit microeconomic optimization behaviour of CGE models with the asset portfolio behaviour of macroeconomic models to analyse the impact of adjustment programs on two archetype economies, a low income country in Africa; and a middle income country in Latin America. The authors found that devaluation increased the welfare of the poor in a low income country partly because it was the exporting country while reduced government expenditure had little impact on income distribution and hurt the middle income modern sector workers because of unemployment and lower growth. Using a similar modeling framework, Dervis *et al*., (1982) and de Melo and Robinson (1982) examined the effects of adjustment programs in three archetype economies: a primary exporter, a manufacturing exporter, and a closed economy. They found that the distributional implications of an external shock depended on the initial structure of the economy and the choice of adjustment policies. In addition, Kayizzi Mugerwa (2001) used a multi-sectoral short-run equilibrium model to investigate the impact of structural adjustment policies in Zambia. He found that adjustment policies including those that were sector specific had indirect but not necessarily benign effects on the rest of the country.

Lambert, Schneider, and Suwa (1991) applied a CGE modeling framework to study the effects of adjustment programs in Cote d'Ivorie. They simulated the model using three experiments: a reduction in current expenditure, an increase in taxes, and currency devaluation. They found that reductions in current expenditure through public employee wage cuts reduced income inequality but were ineffective in reducing poverty. Along the same lines, Dorosh and Sahn (2000) applied a CGE modeling framework to four African economies namely Cameroon, The Gambia, Madagascar, and Niger to study the impact of macroeconomic policy reforms on the real incomes of poor households. They found that trade and exchange rate liberalisation benefitted rural and urban poor households in the selected economies by increasing employment and agricultural exports. However, with alternative policy reforms they found that, in order to increase investment and savings, reducing government recurrent expenditures was generally a more efficient and equitable policy than increasing trade taxes. However, the small magnitude of the gains in average real incomes of poor household groups studied suggest that macroeconomic policy reforms alone are inadequate in the short run to significantly reduce poverty in Africa.

Other studies have contributed to this debate by developing a dynamic CGE model of the Ethiopian economy (Gelan, 2002). Gelan ignored the full employment assumption made in Dorosh and Sahn (2000). Gelan found that the effects of trade liberalisation were affected by the choice of labour market closures. In addition, trade liberalisation adversely affected overall economic growth when real wages are fixed in urban areas. He attributed this to contractions in urban areas. He suggests that the success of trade liberalisation is affected by the degree of product and labour market reforms. Unlike Dorosh and Sahn, Gelan's model did not make any distinction between skilled and unskilled labour categories.

Similarly, De Janvry, Sadoulet, and Fargeix (1991) applied a CGE model to analyse the effects of adjustment programs in Ecuador. The authors were particularly interested in analyzing the effects of income transfers and reduced current expenditure on growth and household welfare. They found that the reduction in current expenditure was the best policy for restoring growth and protecting the rural poor. Along the same lines, Thorbecke (1991) used a highly disaggregated SAM based CGE model for Indonesia to explore the impact of stabilisation and structural reform adjustment policies. He experimented with six exogenous policy shocks (i.e. reduced government expenditure, increased public investment and reduced current expenditure, reduced public investment and increased current expenditure, accelerated devaluation, monetary contraction and monetary expansion). His findings suggested that to a larger extent, the above policy shocks were successful in restoring macroeconomic equilibrium and improving income distribution.

Morrison (1991) developed a CGE model for Morocco. He performed simulations with two sets of adjustment programs: short-term stabilisation programs (i.e. devaluation, reduced public investment, slower growth in domestic credit, and employment), and medium term structural adjacent programs (i.e. trade liberalisation, agriculture and financial market reforms). He found that in both adjustment programs, trade liberalisation reduced internal and external deficits while maintaining economic growth and preventing an increase in poverty.

Recently, Decaluwe, Robichaud, and Hassine (2010) applied the CGE modeling framework to study the impact of agriculture trade liberalisation and productivity growth on poverty alleviation. The authors argued that conventional models always ignored the channels linking technical change in agriculture, trade openness and poverty. The authors estimated productivity effects arising from high levels of trade using the latent class stochastic model, and combined these effects with a general equilibrium analysis of the Tunisian economy. They found that poverty declined under agricultural and full trade liberalisation. This decline was much more pronounced when the productivity effects were included. Another study estimated the effects of reforming European agriculture trade policy on poverty in Europe and in the developing world (Winters, 2005). Winters set a conceptual framework linking poverty and trade liberalization and used the CGE model to analyse the effects of a possible agreement in the Doha Round of the World Trade Organisation (WTO). He then conducted a global simulation on European agricultural liberalisation and by comparing it with the Doha simulations, inferred the poverty effects in the developing world. He found that these effects were benign but not very large. However, he argued that this does not change the case for reform, but the Common Agricultural Policy (CAP) harmed trade relations with developing countries and caused poverty in Europe.

Coxhead and Warr (1995) built a CGE model of the Philippines economy and used it to analyse the impact of technical change in agriculture on poverty. They found that when poverty sensitive welfare weights are used, partial equilibrium analysis generally produced smaller welfare gains than general equilibrium analysis. Along the same lines, Decaluwe, Robichaud, and Hassine (2010) developed a dynamic CGE model and applied it to the Senegalese economy. The authors integrated the growth and productivity gain effects of trade liberalisation and its long-run impacts on welfare and poverty. They found that the distributional effects between the poor and non-poor depended upon the specific nature of trade liberalisation policies adopted and the characteristics of the socioeconomic group in which it occurred. Their simulation results suggest that the principle beneficiaries were high skilled urban workers.

Finally, Mabugu, Decaluwe, Forfana, Cockburn, and Chitiga (2007) used the CGE modeling framework to analyse the effects of trade liberalisation on gender and welfare in South Africa. The authors built a macroeconomic framework that distinguished between market and non-market activities, and between female and male workers. Their findings revealed a strong gender bias against women and a decrease in their labour market participation, particularly black African women who were dominantly engaged in contracting sectors. In addition, the authors found that compared to women, the labour participation rate for male workers was higher and that males experienced an increase in their real wages and had a relatively higher share of income in total household income. Female workers did not gain much from trade liberalisation partly because they allocated a greater part of their working time to domestic work and this reduced their earnings from paid labour.

3.5 Selected Applications of CGE Modeling in Uganda

A number of studies have applied the CGE modeling framework to study the impact of external policy shocks on Uganda's economy. These include: tariff liberalisation and welfare (Mbabazi, 2002); agricultural trade liberalisation and poverty alleviation (Morrissey *et al*., 2001); aid allocation and its impact on growth and poverty (Matovu *et al*., 2009); tax widening and evasion (Matovu *et al*., 2009); agricultural sector growth and poverty reduction (Thurlow *et al*., 2008); Welfare and production effects of technical change in Uganda's agriculture sector (Dorosh *et al*., 2002); and tax reforms and their impact on welfare (Matovu *et al*., 2009). A summary of these studies, methodology used, type of simulations, and closure rules adopted, and main findings are presented in Table 3.5.1 below

Table 3.5.1 Applicability of CGE Modeling in Uganda: A Review of the Literature

Author/s	Title of Study	Methodology and Data	Simulations Performed	Main Findings
Thurlow, J. and P. Dorosh (2009).	Agglomeration, Migration, and Regional Growth: A CGE Analysis of Uganda	Uganda has experienced rapid economic growth and poverty reduction over the past decade but has failed to significantly improve incomes in its northern regions where prolonged conflict has hindered growth. To close this regional divide, the authors consider three strategies: First, developing a north-south corridor to encourage regional trade, (2) accelerating growth in the southern capital city and encouraging north-south migration, and (3) improving agricultural productivity in rural areas. **Model and Data:** To assess the growth and distributional impacts of alternative investment options, the authors developed a regional CGE model for Uganda. The model is recursive dynamic and is run over the period 2005–2015. The model is initially calibrated to the 2005 regional Uganda SAM, which provides information about demand and production for 47 detailed sectors in each of the five regions (northern rural, northern urban, southern rural, southern urban, southern rural and the Kampala metropolitan use of primary inputs such as land, labour, and capital, and intermediate inputs. In summary, the CGE model incorporates regional growth linkages and distributional change by (1) Disaggregating production patterns and technology across sectors and regions, (2) allowing interregional labour migration and agglomeration effects, (3) capturing region-specific transaction costs and specifying regional markets for non-traded commodities, (4) capturing income effects through regional factor markets and price effects through national commodity markets, and (5) translating these two effects onto different households in each region	The model is used to examine the regional economic growth and poverty impacts of three growth scenarios: (1) investing in a transport corridor to connect the main urban centres in the northern and southern regions, (2) accelerating growth in Kampala, and (3) improving agricultural productivity in rural areas. **Baseline Scenario:** The baseline provides a counterfactual for other simulations and is calibrated to track growth and demographic trends in Uganda. Specifically, the authors assign initial growth rates for population and labor supply, migration, and total factor productivity based on the period 1992–2005. 1. It is assumed that Uganda's total population grows at a rate of 3 percent per year during 2005–2015. 2. It is also assumed that growth in the total supply of skilled, semiskilled, and unskilled labor is 3 percent per year, implying that the national dependency ratio remains constant over time. 3. Given the concentration of recent growth, the authors assume that initial TFP growth is higher in Kampala and the southern urban centres. Given agriculture's poor performance since the early 1990s, it is assumed that agricultural productivity growth is declining.	–The baseline scenario of the CGE model simulations, which represents a continuation of the productivity gains of the past decade, suggests that high GDP growth (6 percent per year), largely concentrated in the south, would result in rapid overall annual per capita consumption growth (4.0 percent) but a widening regional gap as Kampala consumption rises by 4.6 percent per year while per capita consumption in the north grows by only 2.4 percent per year. Poverty rates in the north would decline by 6.5 percent—in the rural north to 57.6 percent—but this would still dwarf poverty rates in the rural south (19.8 percent) and the urban south (4.3 percent). –Simulations of the impact of reducing transaction costs between the northern and southern urban centres indicate that this policy has only modest effects on regional growth and poverty reduction, reflecting the smaller size of the overall investment. –Improvements in the north-south transport corridor benefit northern households, but the effects are limited by the small size of the northern urban centres, which currently contain less than 1 percent of Uganda's population, and are dominated by low productivity of northern agriculture producers. –Increasing agriculture productivity in rural areas has a much more positive impact on growth and poverty reduction in northern Uganda, a region where current crop yields are far below potential yields.

Source: Compiled by author.

Table 3.5.1 Applicability of CGE Modeling in Uganda: A Review of the Literature Cont'd

Author/s	Title of Study	Methodology and Data	Simulations Performed	Main Findings
Thurlow, J. and P. Dorosh (2009).	Agglomeration, Migration, and Regional Growth: A CGE Analysis of Uganda	According to their factor endowment and income and expenditure patterns. This allows the model to capture the regional growth and distributional effects associated with alternative investment scenarios. **Closure Rules:** Skilled and semiskilled workers are assumed to be fully employed with flexible nominal wages. By contrast, rural unskilled labour has an upward-sloping labour supply curve to capture underemployment and incentives from rising wages. Within each period workers in the model can migrate across sectors within each region, but between periods they can migrate across regions in response to wage differentials. Capital is assumed to move freely across sectors within a region. The model distinguishes between formal and informal capital. For the current account, a flexible exchange rate maintains a fixed level of foreign savings. This means that the government cannot increase foreign debt to pay for new investments and that export earnings are needed to pay for any additional imports. For the government account, tax rates are fixed, and recurrent expenditure grows at a fixed rate. The fiscal deficit therefore adjusts to ensure that public expenditures equal receipts. Investment and private consumption are also fixed shares of absorption, with private savings adjusting to ensure that savings equals investment in equilibrium.		**Summary:** Overall, the results indicate that if Uganda continues on its current growth path of Kampala centred growth, regional inequality will worsen and poverty rates will remain very high in the northern region. Only with rapid productivity growth in agriculture would result into the reduction in the income gap between north and south and overall poverty rates in the north.

Source: Compiled by author.

Table 3.5.1 Applicability of CGE Modeling in Uganda: A Review of the Literature

Author/s	Title of Study	Methodology and Data	Simulations Performed	Main Findings
Thurlow, J. *et al.*, 2008.	Agriculture Growth and Investment Options for Poverty Reduction in Uganda.	A recursive dynamic CGE model is developed and used to examine how accelerating growth in various agricultural crops and sub-sectors could help Uganda achieve the CAADP target of six percent agricultural growth, especially when supported by raising agricultural expenditure to at least 10 percent of the government's total budgetary resources between 2010/2011 and 2014/2015. **Data:** The model is calibrated to a 2005 social accounting matrix (SAM) that provides information on demand and production for 50 detailed sectors. The growth-poverty relationship is examined by combining the CGE model with a micro simulation model. The model is run over the period 2005-2015, with each equilibrium period representing a single year. **Closure rules:** All labour types in the model (i.e. self-employed agricultural workers, and unskilled workers) employed in both agriculture and non-agricultural sectors and skilled non-agricultural workers can migrate between sectors. Capital moves freely within the broad agricultural and non-agriculture sectors, and is accumulated through investment financed by domestic savings and foreign inflow. For the current account, a flexible exchange rate maintains a fixed level of foreign savings. For the government account, tax rates and real investment adjusts to changes in savings.	1. A 20 percent increase in public agricultural spending between 2010 and 2015 on agricultural GDP growth. Under this scenario, the accelerated growth in agricultural GDP requires an associated growth in public spending on agriculture from the baseline value of 19.4 to 30.2 percent per year under the high elasticity scenario and 30 to 38.3 percent under the low elasticity scenario 2. A 10-20 percent increase in non-agricultural sector spending between 2010 and 2015 on agricultural GDP growth. Under this scenario, public spending on agriculture is expected to grow at 25.6 percent per year under the high elasticity scenario and 30.7 percent under the low elasticity scenario.	These results confirm the importance of Uganda meeting the Maputo declaration by allocating at least ten percent of the government's total budget to agriculture. In fact, the results suggest that even under a more efficient spending scenario (i.e., high elasticity), the government will need to allocate at least 14 percent of its total budget to agriculture by 2015 in order to achieve the CAADP growth target of six percent growth in the agricultural sector per year. Under the CAADP scenario, agricultural growth accelerates from 2.7 to six percent per year during 2004-2015, while non-agricultural GDP growth increases marginally from 4.2 to 4.6 percent per year, and total GDP growth increases from 5.1 to 6.1 percent per year. Agricultural growth at six percent per year would increase overall GDP growth from 5.1 to 6.1 percent per year. This higher growth rate would reduce national poverty to 18.9 percent by 2015, which is lower than the 26.5 percent poverty rate that would be achieved without the additional agricultural growth. This means that the higher growth under the CAADP scenario would lift an additional 2.9 million Ugandans above the poverty line by 2015. Further, rural households will benefit more than urban households, because rural households are more dependent on agricultural incomes. In addition, while rural poverty falls by an additional 8.4 percentage points, urban poverty falls by three percentage points.

Source: Compiled by author. CAADP: Comprehensive African Agricultural Development Program.

Table 3.5.1 Applicability of CGE Modeling in Uganda: A Review of the Literature Cont'd

Author/s	Title of Study	Methodology and Data	Simulations Performed	Main Findings Cont'd
Thurlow, J. *et al.*, 2008.	Agriculture Growth and Investment Options for Poverty Reduction in Uganda.	These two assumptions allow the models to capture the effects of growth on the level of public investment and the crowding-out effect from changes in government revenues. Because of its strong linkages with the rest of the economy, agriculture is key to Uganda's growth process. The model captures production linkages by explicitly defining a set of nested constant elasticity of substitution (CES) production functions, and allowing producers to generate demand for both factors and intermediates. Finally, the CGE model is recursive dynamic, which means that some exogenous stock variables in the models are updated each period based on inter-temporal behaviour and the results from previous periods. The model is run over the period 2005-2015, with each equilibrium period representing a single year. The model also exogenously captures demographic and technological change, including population, labour supply, human capital and factor-specific productivity.		Conclusion: The model CGE model results indicate that it is possible for Uganda to reach the CAADP target of six percent agricultural growth, but this will require additional growth in a number of crops and sub-sectors. Uganda cannot rely on a few crops or sub-sectors to achieve its growth targets. Broader-based agricultural growth, including increases in fisheries and livestock, will be important if this target is to be achieved. So, too, is meeting the Maputo declaration of spending at least ten percent of the government's total budget on agriculture. The results further suggest that the Government of Uganda will have to increase its spending on agriculture in real terms by about 25.3 percent between 2006 and 2015. While the country is on track to achieve the first Millennium Development Goal of halving poverty by 2015, achieving the CAADP growth target should remain a high priority, since it will substantially reduce the number of people living below the poverty line and significantly improve the well-being of both rural and urban households.

Source: Compiled by author.

Table 3.5.1 Applicability of CGE Modeling in Uganda: A Review of the Literature Cont'd

Author/s	Title of Study	Methodology and Data	Simulations Performed	Main Findings
Matthews, A. and O. Boysen (2008).	Poverty Impacts of an Economic Partnership Agreement (EPA) between Uganda and the EU.	A qualitative analysis is performed using the 1999 Uganda Social Accounting Matrix and the 2002/2003 household survey. The poverty impacts of trade liberalisation are analysed solely through the requirement that Uganda as an EAC member will have to reduce over time its tariffs on EU imports. A Computable General Equilibrium (CGE) - micro simulation model which enables the quantification of the adjustment impacts on the economy following EPA liberalization and the impacts on overall poverty is implemented. The SAM is inflated using a GDP deflator to be compatible with the numbers of the household survey base year 2002/2003. The SAM comprises 26 commodities, 25 activities, 4 factor of production including both skilled and unskilled labour, 1 household as well as government and rest of the world accounts. **The CGE Model:** The CGE model adopted in this study follows the IFPRI Standard Computational General Equilibrium Model in GAMS (Löfgren *et al*.; 2002). The model is a static, non-monetary, single country model. The CGE model adopts the IFPRI Standard Computational General Equilibrium Model in GAMS (Löfgren *et al*.; 2002). The model is a static, non-monetary, single country model. All representative agents optimize – rationally and fully informed – their individual benefits resulting in a market-cleared, no-profit equilibrium.	Three scenarios are considered. In each scenario sufficient tariff lines are exempt from liberalisation to account for 17.9 percent of initial EU imports. **Scenario 1**: The EPA-EAC scenario assumes that the EAC as a whole tries to retain as much tariff revenue as possible and selects exempted tariff lines up to a maximum of 17.9% of 2006 EU imports accordingly (i.e. EAC has to liberalize 82.1% of imports from the EU so that 17.9% can be exempted in the list of sensitive products) **Scenario 2**: EPA-UGA scenario in which Uganda optimizes the tariff schedule with respect to sensitive products to minimize its own tariff revenue loss. **Scenario 3:** EPA-AG scenario, Uganda's first priority is to protect its agricultural sector and then to minimize tariff revenue loss from the remaining sectors. **Qualitative Analysis of Poverty:** In order to approach the question about the impact of signing an EPA with the EU, we first establish intuitively how trade liberalization is linked to poor Ugandans following the chain of cause and effects. We then look at the data on trade relations between Uganda and the EU as well as at the UNHS to obtain an impression of the magnitude of the trade shock and its impact potential for the Ugandan economy and the poor population. There are mainly three channels through which trade liberalisation impact on poverty (McCulloch *et al*., 2001).These are the consumption, the enterprise, and the government channel.	The qualitative analysis of the data derived from the Uganda National Household Survey (UNHS) 2002/2003 confirms that Uganda is an agriculture-centred economy with most people living in rural areas and being dependent on agriculture. In addition, the analysis shows that the scope for trade liberalisation with the EU is very limited. Specifically, the poor have only weak links to formal markets. **CGE Simulations:** The EPA impact is then quantified using a single country CGE model for Uganda. Starting from the EAC's common external tariff and its free trade area, all EPA scenarios result into negligible effects on GDP and a small increase in trade activity. Exports increase more than two fold compared to imports. The sales tax rates, which adjust to compensate for lost tariff revenue, increases by 4 percent to 9 percent. Returns to labour decrease where skilled labour loses more compared to unskilled labour. In addition, returns to capital decrease. But returns to land increase relatively more than returns to each of the other factors are reduced. **Exports and Imports:** The sectoral changes of imports, exports, and domestic production exhibit similar tendencies in all EPA scenarios. Imports increase slightly for all agricultural and manufacturing sectors apart from petroleum and chemicals. Imports decreases for the construction, commerce, and trade sectors. Regarding exports, significant increase is in coffee processing and manufacturing.

EAC: East African Community; UG: Uganda; AG: Agriculture; EU: European Union: ACP: Africa, Caribbean, and Pacific (trading block); EPA: Economic Partnership Agreements.

Table 3.5.1 Applicability of CGE Modeling in Uganda: A Review of the Literature Cont'd

Author/s	Title of Study	Methodology and Data	Simulations Performed	Main findings Cont'd
Matthews, A. and O. Boysen (2008).	Poverty Impacts of an Economic Partnership Agreement (EPA) between Uganda and the EU.	**Poverty Measure**: For measuring poverty, they apply an absolute poverty line and the measures P_α introduced by Foster, Greer and Thorbecke (1984). The authors compute the poverty headcount, gap and severity index, respectively. We use a national as well as rural and urban poverty lines which have been recovered from the adjusted household survey data in order to reproduce the poverty headcounts reported in the UNHS Report on the Socio-Economic Survey (Uganda Bureau of Statistics, 2003). Poverty lines are based on the cost of basic needs approach which accounts for the cost of meeting physical calorie needs and allowing for vital non-food expenditure such as clothing and cooking fuels. These items are valued using the average consumption basket of the poorest 50% of the population. The rural and urban poverty lines account for the differences in prices and consumption baskets for the respective subpopulations. Per Capital income is the income measure. **The micro simulation model** This model is a non-behavioural micro accounting model which simulates the first order effects of changes in commodity prices and factor returns given by the CGE model on household incomes based on the representative household sample collected in the UNHS. No reactions to price changes are assumed on the household side thus the simulation reflects explicitly the short-term implications on the income distribution.	**The Consumption channel** Import tariff liberalization reforms initially affect the prices of the imported commodities and their substitutes on the domestic market. As consumers, individuals are affected by changes in their goods' prices which change the purchasing power of their incomes. **Enterprise Channel** As producers, their profits directly depend on prices for inputs and outputs, or, as workers, price changes affect enterprise profits and thus factor demand which materializes in employment and wage changes. **The Government channel** As citizens, people are affected by way of tariff revenue loss-induced changes in government policies regarding direct transfers, taxes, and provision of public goods and social services.	**Domestic Production** Domestic production reacts to import liberalization by decreasing almost all production activities in the agricultural and manufacturing sectors. The coffee and processing sector are the largest beneficiaries. Their production increase by 1.3 percent and 3 percent depending on the EPA scenario. In addition, utilities, construction, commerce, and transport benefit slightly from this scenario. Overall, the coffee sector appears to be the driver of the export growth. It experiences only a negligible negative import price shock and profits strongly from reduced import prices of its intermediary inputs as well as from cheaper unskilled labour which is released from the other agricultural and light manufacturing sectors. Since unskilled labour is released abundantly compared to land, the relatively land-intensive production of coffee drives up land returns. **Micro simulations** The impact of changes in prices and factor incomes on household incomes and poverty are analysed. In the CGE simulation results, returns to unskilled labour, but also to skilled labour and capital, fall but the prices for staples and grain milling products increase slightly while the prices for manufacturing tend to fall, making the impact on the poor population ambiguous. Land, which is primarily owned by households in richer deciles, is the only factor that benefits. The EPA scenarios appear to have a generally minor impact on the poverty headcount P_0 of -0.04 to 0.03 percentage points.

Source: Compiled by author.

Table 3.5.1 Applicability of CGE Modeling in Uganda: A Review of the Literature Cont'd

Author/s	Title of Study	Methodology and Data	Simulations Performed	Main Findings Cont'd
Matthews, A. and O. Boysen (2008).	Poverty Impacts of an Economic Partnership Agreement (EPA) between Uganda and the EU.			**Micro simulations and Poverty** The Uganda optimized scenarios have a slightly decreasing effect in contrast to the EAC-optimized scenario, which has a slightly increasing effect on the poverty headcount. The impacts differ for rural and urban areas. Rural areas generally experience an improvement but urban population deteriorate. All scenarios are associated with a constant or increasing poverty gap P_1. In all the three realistic EPA scenarios, between 0.07 and 0.11 percent of the population fall into poverty, while between 0.09 and 0.1percent are lifted out of poverty. Between 55 percent and 67 percent of the poor population experience a widening of their individual poverty gaps. The Gini index indicates a worsening of income inequality. **Incomes:** Changes in mean real incomes by decile are biased against the poor where loss of average income in the lower deciles turns to gains for the richer deciles. This reflects the higher income shares of the richer spent on manufactures and services for which prices have decreased more strongly than for basic foods and also higher prevalence of land ownership, the only factor which gained. **Summary:** The quantitative analysis of the EPA scenarios confirms that the agreement with the EU will have only a minor impact on the Ugandan economy and Uganda's poor population. Importantly, it shows that such an agreement does not induce large deindustrialization effects and that the economic adjustment costs for Uganda and the poor population are quite low. Nevertheless, whether the small poverty effects are negative or positive depends on the choice of the tariff lines for exemption from liberalization, although under all scenarios the ultra-poor appear to lose.

Source: Compiled by author.

Table 3.5.1 Applicability of CGE Modeling in Uganda: A Review of the Literature Cont'd

Author/s	Title of Study	Methodology and Data	Simulations Performed	Main Findings
Ssenoga, E., J. Matovu, and E. Twimukye (2009).	Tax Evasion and Widening in Uganda.	This study seeks to examine the various options of expanding the tax base by reducing tax evasion and targeting the informal sector which largely does not pay taxes. Specifically, the study seeks to analyse 1. The implications of widening the tax base on the informal sector; 2. The general equilibrium effects of reducing tax burden on the overtaxed sectors while introducing the new taxes in new sectors; 3. The implications of reducing tax evasion and the implied reduction on the financing requirement that could lead to crowding-out effects and 4. Quantify the welfare effects of introducing the new taxes like the local service tax **The Model:** A CGE model based on the standard model developed by Lofgren, Harris, and Robinson (2002) is developed and calibrated to the 2007 SAM for Uganda. Like other conventional SAMs, the Uganda SAM is based on a block of production activities, involving factors of production, households, government, stocks and the rest of the world. The SAM is a 120x120 matrix. The 2007 Uganda SAM identifies three labour categories disaggregated by skilled, unskilled and self-employed. Land and capital are distributed accordingly to the various household groups. Households are disaggregated according to location (rural and urban) and activity (farming and non-farming). **Closure rules: Factor markets** There are 6 primary inputs: 3 labour types, capital, cattle and land. Wages and returns to capital are assumed to adjust so as to clear all the factor markets. Unskilled and self-employed labour is mobile across sectors while capital is assumed to be sector-specific.	The purpose of simulations in this study is to find how revenues can be raised without necessarily affecting the growth of the economy and worsening equity within household groups. **Simulation 1:** improving tax effort (revenue collection) by 10 percent. As in other simulations, statutory tax rates are not increased. Rather, it is assumed that Uganda Revenue Authority would improve on tax administration which would subsequently result into higher revenues collected. **Simulation 2:** Excluding of all food items from higher tax collection. Food items which make the largest composition of the consumption basket for poor households and unprocessed food items are exempt from VAT. However, processed foods which are largely sold through supermarkets are subject to taxes. **Simulation 3a:** Increasing the tax collection effort among non-farm urban based households **Simulation 3b:** Increasing tax effort of urban based households who live in urban areas but own farms which are not for subsistence production. **Simulation 4:** Looking beyond the local service tax**,** the authors perform a simulation where they apply the thresholds on households who are based in urban areas. While it can be argued on equity grounds that these households tend to be poorer, there are households which are fully captured in the income tax category with equal or less income than the informal sector workers. For instance, teachers and Policemen earn on average less than UG 400,000 shillings a month which is taxed.	Over the simulation period of five years, consumption for rural households would be lower than the baseline by 0.5 percent. The intuition behind this result is that while attempting to increase domestic taxes, this has to be done selectively by focusing more on goods that are mainly consumed by the rich. **Macro economy**: The overall deficit would be reduced by 3 percent in the baseline. This would have various implications at the macroeconomic level. Domestic borrowing reduces which reduces interest rates. Thus, private investment increases by 2.6 percent over the simulation period. All households would be affected by increased consumption tax collection effort but rural households would be affected most. **Simulation 2 Results:** Consumption of rural based households would not be negatively affected compared to simulation 1. The consumption foregone by all household groups (as measured by the expenditure equivalent variation measure) would be much less compared to simulation 1. This suggests that the policy stance of improving tax collections while excluding the food items would be more progressive. **Simulation 3a results:** This simulation would result into a reduction of the welfare of the households targeted. However, the welfare for all the other households improves relative to the baseline and indication that they are not overburdened by the tax system.

Source: Compiled by author.

Table 3.5.1 Applicability of CGE Modeling in Uganda: A Review of the Literature Cont'd

Author/s	Title of Study	Methodology and Data	Simulations Performed	Main Findings Continued
Ssenoga, E., J. Matovu, and E. Twimukye (2009).	Tax Evasion and Widening in Uganda.	**Macro closures:** Three macro closures are specified in the model. These are: the fiscal balance, the external trade balance, and savings-investment balance. For fiscal balance, government savings is assumed to adjust to equate the different between government revenue and spending. For external balance, foreign savings are fixed with exchange rate adjustment to clear foreign exchange markets. For savings-investment balance, the model assumes that savings are investment driven and adjust through flexible saving rate for firms.		**Simulation 3b results:** Increasing the tax collection effort among this group would reduce their welfare but the welfare of Kampala based households residing would improve. This suggests that indeed Kampala residents could be overburdened by the income tax system. By rolling the tax system out to other urban centres in the form of the local service tax would reduce the burden of Kampala financing the Local Governments upcountry. **Conclusion:** This study has revealed that Uganda still lags way behind in its tax collections at the domestic level. For most commodities, the tax collection effort is not more than 5 percent relative to the statutory rate of 18 percent. This results into a situation where the government has to rely a lot on foreign financing. The study identified specific areas which Uganda Revenue Authority could target to improve tax collection. The study estimates that about 53 billion shillings is untapped. This could be collected by targeting businesses, commodities that are untaxed, while excluding food items for welfare/equity purposes.

Source: Compiled by author.

Table 3.5.1 Applicability of CGE Modeling in Uganda: A Review of the Literature Cont'd

Author/s	Title of Study	Methodology and Data	Simulations Performed	Main Findings
Matovu, J., E.Twimukye, W. Nabiddo, M. Guloba (2009).	Impact of Tax Reforms on Household Welfare	–The allocation of domestic output between exports and domestic sales is determined using the assumption that domestic producers maximize profits subject to imperfect transformability between these two alternatives. The production possibility frontier of the economy is defined by a constant elasticity of transformation (CET) function between domestic supply and exports. –On the demand side, a composite commodity is made up of domestic demand and final imports and it is consumed by households, enterprises, and government. The Armington assumption is used here to distinguish between domestically produced goods and imports. For each good, the model assumes imperfect substitutability (CES function) between imports and the composite domestic good. Parameters used to calibrate the CET and CES functions (i.e. elasticities) are exogenously determined and are taken from Chung-I Li (1999). **Closure Rules:** All factors are assumed to be mobile across activities. For labour, fixed employment and market clearing wages are assumed. Three macro closures/balances are specified in the model: For fiscal balance, government savings is assumed to adjust to equate the different between government revenue and spending. For the current account, foreign savings are fixed and exchange rate adjusts to clear disequilibrium on the current account. For savings-investment balance, the model assumes that savings are investment driven and adjust through flexible saving rate for firms.	To assess whether the tax regime is progressive, the authors perform a simulation by assuming no VAT is levied and that the budget is mainly financed by sales tax and direct income taxes. In all cases, we remove VAT while at the same time considering the following revenue tax changes. **Scenario 1:** Revenue losses are not compensated for by adjusting any other forms of taxes. **Scenario 2:** Revenue loss after the removal of VAT is compensated for by increasing direct taxes on households uniformly; and **Scenario 3:** Revenue loss is mainly compensated for by households in the fourth quartile (richer households). **Scenario 4**: Assessing the progressiveness of the tax system if all food items and agricultural commodities are zero rated.	**Macroeconomic effects:** –Under flexible and fixed tax deficits the trade balance improves: Exports increase by 0.1 percent, imports increase by 0.04 percent. –**Intuition:** Exports become cheaper and are now more competitive in the international markets. Overall GDP increases due to increased domestic activities as the elimination of VAT reduces both the cost of production and market prices for the domestic consumers. In a scenario where the reduction of VAT is financed by richer households, the trade balance is negatively affected (exports decrease by about 0.3 percent while the imports decrease by about 0.2 percent). The impact on other variables is marginal. –Removing excise tax on manufactured goods impacts negatively on the macro economy under both the flexible and fixed tax deficit regimes. Exports decline by 0.24 percent, while imports decrease by 0.16 percent, thereby negatively affecting the trade balance. –The negative net indirect taxes may be due to a decrease in the excise tax itself. The negative impact on the macro economy can partly be explained as follows: The removal of excise taxes leads to reduced government revenue which ultimately reduces its expenditure and implementation of socioeconomic programs, thus dampening economic growth. Increasing excise tax on petrol products impacts negatively on the macro economy and the trade balance is slightly affected. Whereas taxation of petrol (consumed mainly by the rich), may be considered to be a progressive move, its effects can be felt in the transport sector, thereby affecting the entire economy.

Source: Authors compilation.

Table 3.5.1 Applicability of CGE Modeling in Uganda: A Review of the Literature Cont'd

Author/s	Title of Study	Methodology and Data	Main Findings Cont'd	Main Findings cont'd
Matovu, J., E.Twimukye, W. Nabiddo, M. Guloba (2009).	Impact of Tax Reforms on Household Welfare.		**Welfare effects of simulations** –With the removal of VAT across the board, the welfare of rich households improves. Such households mainly consume manufactured items on which VAT is levied. The removal of VAT is indeed good for the poor and made the tax system more progressive (Chen *et al*., 2001). –If VAT tax revenue losses are mainly financed by households in the fourth quartile, the welfare of urban households decline. Households in Q4 bear the burden of the tax. Caution should be taken not to over tax the rich because this could have negative effects on the economy because high taxes reduce savings and investments. Meanwhile, the welfare of households in other quartiles improved because the taxation system became more progressive which impacted positively on the poorer households. –The removal of VAT on all food items benefitted urban households instead of households in the lower quartiles. This is because urban households are the main consumers of food products that are VAT eligible. Urban households switch to manufactured goods and reduce their demand for goods from rural areas which reduce the welfare of rural households. –The thrust for this policy stance is to minimise the costs of administrating tax collection since it is administratively cheaper to target rich tax payers. The welfare of Q4 households declines because they bear the burden of the tax. Welfare Households in the remaining quartiles improves because they fall outside the tax bracket. The income tax in this scenario is progressive because it improves the welfare of the poor households.	–Increasing taxes on manufactured goods considered luxurious and mainly consumed by the rich is found to increases the welfare of rural households compared to urban households. –Increasing excise tax on petrol generally had a negative impact on all households groups. This could be explained by the fact excise tax on petrol directly or indirectly affects all economic activities that use petroleum such as transport and manufacturing. **Summary:** The government could strengthen VAT and streamline it so that it is captured at the production and consumption stages thereby increasing the tax base. At the moment, it is only paid by registered companies. Second, to stimulate production in the agricultural sector, all agricultural activities should be fully exempted from VAT. This would make the tax system more progressive as most of the low income households depend on the agricultural sector. Finally, whereas excessive taxation may not directly affect the welfare of the poor household groups; Uganda revenue authority should strike a balance between excessive taxation of a few selected luxury goods and the quest for revenue mobilisation. Excessive taxation of such goods might reduce their consumption and lead to low revenues being collected.

Source: Compiled by author.

Table 3.5.1 Applicability of CGE Modeling in Uganda: A Review of the Literature Cont'd

Author/s	Title of Study	Methodology and Data	Simulations Performed	Main Findings
Matovu, J., W. Nabiddo, and E. Twimukye (2009).	Aid Allocation Effects on Growth and Poverty: A CGE Framework.	About 30 percent of Uganda's budget is financed by aid (Uganda Budget, 2009/2010). This paper investigates whether increased aid causes the Dutch disease through the appreciation of the country's currency which in turn reduces export competitiveness. **Data Sources:** The study uses the 2007 SAM. Like other conventional SAMs, the Uganda SAM is based on a block of production activities, involving factors of production, households, government, stocks and the rest of the world. The SAM identifies three labour categories disaggregated as skilled, unskilled and self-employed. Land and capital are distributed accordingly to the various household groups. Households are disaggregated according to location (rural and urban) and activity (farming and non-farming). A recursive CGE model is developed and calibrated to the SAM. **Closure rules: Factor markets**: There are 6 primary inputs: 3 labour types, capital, cattle and land. Wages and returns to capital are assumed to adjust so as to clear all the factor markets. Unskilled and self-employed labour is mobile across sectors while capital is assumed to be sector-specific. **Macro closures:** Three macro closures are specified in the model. For fiscal balance, government savings is assumed to adjust to equate the different between government revenue and spending. For the current account, foreign savings are fixed and exchange rate adjusts to clear disequilibrium on the current account. For savings-investment balance, the model assumes that savings are investment driven and adjust through flexible saving rate for firms.	**Baseline Scenario**: The baseline scenario serves as benchmark for comparison of simulations. It is assumed that business continues as usual with no specific changes made to policy. Foreign aid under the baseline scenario is assumed to grow at a modest rate of 3 percent per annum. It is assumed that government increases its spending by a similar growth rate. We assume that growth in total factor productivity (TFP) for all sectors is about 1 percent and this generates about 6 percent for real GDP growth under the baseline. **Scenario 1: Foreign aid increases by 5 percent but it is not used for any productive activity:** It is has been argued that Aid increases would lead to increase in demand and the prices for tradables such as services. This makes jobs in the tradable sector less attractive, leading to contraction of economic growth. **Scenario 2:** Aid is used to finance infrastructure projects. The argument is that producers of tradables would then have access to markets and thereby mitigate the losses as a result of the appreciation due to the increased flows. **Scenario 3: Increased aid allocation to agriculture sector.** This simulation is intended to examine the effects of increased aid allocation on agriculture productivity. In this case, Aid would be used to purchase fertilisers, high yielding seeds, harvesting equipment, and training of farmers, among others.	**Scenario 1 Results** –Considerable appreciation of the shilling when aid is assumed to increase by 5 percent during the years 2008-2015. –The effects of this surge in aid flows are consistent with the Dutch-disease theory. Indeed what we find is increased growth in the services sector. –Growth in government services mainly administration and contraction of private services –Significant reduction in agriculture production i.e. production of exportables (coffee, tea, cotton,) decreases. –Economic growth contracts by 0.4 percent every year (2005-2015) due to the loss in export competitiveness –Overall, the local manufacturing sector becomes less competitive as imports become cheaper –Net impact of aid on growth is negative –Increased demand for skilled labour which is not abundantly available results into a reduction in production in the manufacturing sector. **Scenario 2 Results** – Increased spending of aid on infrastructure reduces the effects of currency appreciation. Recovered output would average 0.6 percent of GDP during 2008-2015. The level of exports is below the baseline but much higher than when aid is not productively spent on infrastructure. – The growth pass of Agriculture and manufacturing does not improve because increased spending attracts resources away from tradable to no tradable sectors. On the other hand, the growth pass of services remains high because large infrastructural projects are funded by government.

Source: Compiled by author.

Table 3.5.1 Applicability of CGE Modeling in Uganda: A Review of the Literature Cont'd

Author/s	Title of Study	Methodology and Data	Simulations Performed	Main Findings
Matovu, J., W. Nabiddo, and E. Twimukye (2009).	Aid Allocation Effects on Growth and Poverty: A CGE Framework.	**Recursive dynamics:** The model is extended to capture the dynamic aspects of the economy by building some recursive dynamics. This process follows the methodology used in previous studies on Botswana and Southern Africa (Thurlow, 2007). Capital stock in the next period is derived from investment in the current period. New generated capital is then allocated to sectors based on their profit ability. The labour supply path under different policy scenarios is exogenously provided from a demographic model. The model is initially solved to replicate the 2007 SAM.	**Scenario 4: Investing aid in human capital:** The argument here is to enhance the skills and increase the productivity of workers. The authors assume that increased spending on human capital development would be reflected in improved service delivery (i.e. education and health sectors). In addition, this experiment examine the argument that aid is used to finance social services (non-tradables) it could hurt the economy. However, increased social spending on health and education has other indirect benefits particularly the increased productivity of workers. **Scenario 5: Aid and the reduction in direct taxes:** It can be argued that if the increased aid flow was permanent, rather than improving social services, the government could reward its citizens by reducing direct taxes. In this case, the foreign citizens would be directly financing the consumption of Ugandan households. However, overdependence on aid could reduce domestic revenue collection efforts which could hurt economic growth.	**Poverty Indices:** As resources get shifted to the non-tradable sector, farming and manufacturing becomes unprofitable and this directly affects the incomes of households involved in the two activities. Indeed, with aid not being productively used, an additional 2 percent of the population would be pushed below the poverty line. However, when the aid is used for productive activities, then the number of household living below the poverty line would be reduced to 18 percent. **Scenario 3 Results:** – If aid is appropriately used to enhance productivity in the agricultural sector, this would mitigate the Dutch disease effects associated with the aid flows. If aid is spent in the agriculture sector, annual recovered output would be 0.7 percent of GDP. Exports would be higher compared to when aid is not spent on agriculture. Output from manufacturing would not be affected given its strong linkages with the more productive agriculture sector. The agro-processing sector would also grow in line with other agricultural activities. – On the contrary, the service sector (non-tradable) contracts compared to when aid is not spent productively. – Increase in welfare and reduction in poverty measures among all households. The welfare of citizens increases through higher levels of consumption and this is determined not only by what they produces, but also by the additional consumption and investment that the aid finances.

Source: Compiled by author.

Table 3.5.1 Applicability of CGE Modeling in Uganda: A Review of the Literature Cont'd

Author/s	Title of Study	Methodology and Data	Simulations Performed	Main Findings
Matovu, J., W. Nabiddo, and E. Twimukye (2009).	Aid Allocation Effects on Growth and Poverty: A CGE Framework.		**Scenario 4: Investing aid in human capital:** The argument here is to enhance the skills and increase the productivity of workers. The authors assume that increased spending on human capital development would be reflected in improved service delivery (i.e. education and health sectors). In addition, this experiment examine the argument that aid is used to finance social services (non-tradables) it could hurt the economy. However, increased social spending on health and education has other indirect benefits particularly the increased productivity of workers. **Scenario 5: Aid and the reduction in direct taxes**: It can be argued that if the increased aid flow was permanent, rather than improving social services, the government could reward its citizens by reducing direct taxes. In this case, the foreign citizens would be directly financing the consumption of Ugandan households. However, overdependence on aid could reduce domestic revenue collection efforts which could hurt economic growth.	**Scenario 4 Results** –Increased productivity compensates for all the related negative effects of increasing aid. Generally, growth would be higher by about 0.7 percent if significant aid resources were spent on social services. While the exports goods would be hurt under this scenario, the population would be better off despite the small appreciation. **Scenario 5 Results:** The growth rate is increased by 0.7 percent and is much higher than when aid is not productively used by the government. The Dutch disease effects are dominated by increased resources (household savings) and production of exportable crops. **Summary:** In a scenario where aid is not productively utilized, the major winners are households involved in the services sector especially the public sector. The losers in this case are individuals who are involved in the exportable agricultural commodities. These effects are reversed when aid is spent productively, for example on expanding infrastructure. In all scenarios, the effects on increased aid inflows on poverty depend on how government uses the aid and the target sector/activity. Households benefit if most of the aid is allocated to the agriculture sector. This is partly because agriculture is the dominant sector/employer in rural areas where most poor households live.

Source: Compiled by author.

Table 3.5.1 Applicability of CGE Modeling in Uganda: A Review of the Literature Cont'd

Author/s	Title of Study	Methodology and Data	Simulations Performed	Main Findings
Lindsay Chant, Scott McDonald and Arjan Verschoor (2008).	Some Consequences of the 1994–1995 Coffee Boom for Growth and Poverty Reduction in Uganda.	The study the 1992 Social Accounting Matrix (SAM) of Uganda for 1992 (Blake *et al*., 2000). The final SAM has 128 accounts, of which 50 are commodity accounts, 50 activity accounts, seven factor accounts, 10 household accounts, six government accounts, two capital accounts, and the remaining three accounts are the Government account, the Enterprise account, and the Rest of the World account. **The CGE Model:** The CGE model is developed from the Sheffield Standard Model 3 (Scott McDonald, 2005). The model is in the general class of neoclassical models. The modelling of production relations and factor demands allows for imperfect substitutability between factors, i.e. capital for labour and between different types of labour. The mapping of factor income to households ensures that changes in production activities are reflected in changes in household income levels. Commodity flows in the CGE model depend on the Armington assumption that allows for imperfect substitutability between goods (Armington, 1969). The Armington specification is important for it allows for different degrees of tradability by commodity on the import side. Production quantities of commodities are determined according to relative prices and the degree of substitution that is captured by the CES functions so as to maximise profits. Domestically produced goods are sold either on the domestic or foreign markets, with the share of each determined by the relative sale prices and the ease of transformation (CET function).	We analyse the impact of the coffee price boom on Uganda's economy by comparing two scenarios: baseline and with-boom scenarios. The baseline scenario is a business as usual, counterfactual scenario for which it is assumed that technical progress and labour force growth are exogenously determined while physical capital is endogenously determined. **Scenario 1: Baseline (no boom in coffee prices**): A set of simulations is performed on the state of the economy before the coffee price boom. Growth rates of per capita GDP and supply of labour for the period 1983-1992 were estimated econometrically using a log-linear regression. While usable data are available for 1983–2000, the data from 1992 to 2000 were omitted because they contain the effects of the rising coffee prices. Per capita GDP and labour supply are found to grow at 1 percent per and 2.65 percent per annum respectively; with capital stocks adjusting endogenously, these results are used to calibrate the technical change parameters used in the with-boom scenarios. **Scenario 2: Boom in coffee prices:** In this scenario, the results of technical change and labour supply growth from the baseline scenario are exogenously imposed; capital stock is assumed to be endogenously determined; and the increase in the supply price of coffee is introduced at this stage. As a result, the only difference compared with the baseline is the boom in coffee prices, and hence this scenario seeks to capture the effects of the boom Uganda's economy independent of changes in other economic variables.	**Welfare Gains:** –During the boom years, urban groups benefitted more than rural groups. Urban groups captured 54 percent of the addition to aggregate welfare. This suggests that the per capita effect for urban groups was much higher than that for rural groups. This was attributed to the Dutch disease effect. –The demand for non-tradables such as public services increased in the short run as a result of the spending effect of the boom. As a result, the value-added price for non-tradables increased relative to that of the tradables which explained the real appreciation part of the Dutch disease. –Urban groups do relatively well and that the price effect on welfare dominates the income effect in this case. **Economic Growth** –The authors find that some of the initial growth indeed resulted from a rather modest increase in the capital stock, but did not find substantial evidence for the claim that Uganda's economic performance should be largely attributed to the coffee boom. **Scenario2 results: Poverty Alleviation** –The authors evaluated the claim that the coffee boom was responsible for a substantial part of Uganda's equally remarkable success in reducing the poverty headcount measure. This claim was based on the accounting method that quantified the initial effect of the boom in terms of raising coffee growers' incomes.

Source: Compiled by author.

Table 3.5.1 Applicability of CGE Modeling in Uganda: A Review of the Literature Cont'd

Author/s	Title of Study	Methodology and Data	Simulations Performed	Main Findings
Lindsay Chant, Scott McDonald and Arjan Verschoor (2008).	Some Consequences of the 1994–1995 Coffee Boom for Growth and Poverty Reduction in Uganda.	**Closure rules:** These are selected to reflect the structure of Uganda's economy and the policy reforms of the 1990s. Similar closure rules were applied in the baseline and with-boom scenarios, so that the observed differences are directly attributable to the boom in coffee prices. **Factor markets:** Skilled and unskilled labour is assumed to be fully employed and mobile; The supply of capital increases at an endogenously determined rate. This allowed the analysis of the central hypothesis of the study. That is, the windfall profit that accrued to coffee farmers was translated into more sustained growth through private investment behaviour. **Macro closures:** –For the current account, a flexible exchange rate maintains a fixed level of foreign savings (i.e. exchange rate adjusts endogenously to clear the current account imbalance). Government deficit is fixed in real terms; with foreign savings fixed in foreign-denominated currency and the budget deficit fixed in Ugandan shillings, the indirect (production) tax rate and household income tax rates are free to adjust equiproportionately to ensure that the government account clears; –Growth in capital stock is determined endogenously in the model through the savings behaviour of households; the marginal propensities of households to save are flexible so that the value share of investment in domestic final demand is constant. –All agents are assumed to invest their savings at the end of each year in the purchase of capital. This capital increases the total capital stock and therefore also the supply of capital available to the economy.	In scenario 2 coffee prices from 2000 onwards take the 1999 value. Modelling coffee prices in this way ensures that the long term effects of the boom are captured without the potentially obscuring effects of the coffee price fall of the late 1990s.	**Poverty Alleviation Cont'd** Using a CGE model and including spending and resource movement effects in the analysis, the authors found that urban groups benefitted as much as rural groups from the boom, but farmers benefited only modestly. On the whole, relative price movements were responsible for the greater part of welfare changes, but income effects explained the structure. **Summary** –Small effect on both medium-term growth and poverty reduction. Aid dependence is among the reasons why this effect is not found to be larger. The primary beneficiaries of the coffee boom were not the farmers to which the windfall initially accrued, but urban wage earners and the urban self-employed.

Source: Compiled by author.

Table 3.5.1 Applicability of CGE Modeling in Uganda: A Review of the Literature Cont'd

Author/s	Title of Study	Methodology and Data	Simulations Performed	Main Findings
Mbabazi Jennifer (2002).	A CGE Analysis of the Short-run Welfare Effects of Tariff Liberalisation in Uganda.	The study uses the 1992 Uganda Social Accounting Matrix. The SAM is disaggregated into fifty sectors and 10 household groups. The SAM identifies 6 labour categories disaggregated into wage or non-wage earners and by skill category as high skilled and low skilled. The SAM shows that domestic production is largely demanded by the household sector (61 per cent) while intermediate demand accounted for 19 per cent. The reminder is distributed between government, rest of the world as exports, investment and stocks. Households derived 86 per cent of their income from factor income payments while the rest accrues from government and inter-household transfers. Government account earns 20 per cent of its income from import tariffs, a feature typical of developing countries. It derives 69 per cent from transfers from the Rest of the World, 8 per cent and 3 per cent of its income from taxes on domestic production and household incomes respectively. **The CGE model:** The model is standard static Walrasian neo-classical specification and follows in the tradition of application of CGE models to developing countries (Dervis *et al*. 1982) and standard CGE modelling structures (Blake et al. 1998). It is Walrasian because equilibrium in n markets is assured by equilibrium in (n-1) markets. –Constant returns to scale technology are assumed as well as Leontief relationships. –Standard CES nesting structures for value added as a function of capital and six categories of labour are employed. The double-Armington assumption is used to distinguish imports and domestically produced goods, implying imperfect substitutability and also to differentiate exports from goods for domestic use.	**Simulations:** –The period 1994-200 experienced significant tariff cuts in Uganda. The sub-period 1994-1995 witnessed a substantial increase in tariffs from 17.9% in 1994 to 20% in 1995. The traditional export sector witnessed the highest increase of 19.5%. –The agricultural sector recorded a 9.7% decline in tariff levels during the same period. The period between 1995 and 1996 saw a reduction in the average level of tariffs to 16.2% with the greatest reduction of 36% in the agricultural sector. Between 1996 and 1997 there was a 4% decline in tariffs to an average of 12.3%. Tariff reforms in 1998 brought the mean tariff level down to 9.8%, a level around which it stabilised until 2000/2001.	**Welfare Effects:** First, there are only marginal albeit differential welfare changes for the household groups. Secondly, agricultural households enjoy the greatest gains from the reforms although on average households appear to experience short-run losses from tariff liberalisation. **Intuition:** First, the role of interactions between sectors and factor markets, a key strength of CGE analysis, not surprisingly, plays a central role in welfare outcomes. Although the period 1994/1995 experiences overall increases in tariffs, reduced tariffs in the agricultural sector drives the welfare gains. It induces an increase in imports of agricultural products intensively used in the processing sector which, in turn, expands increasing returns to capital which is intensively used in the sector thereby improving the welfare of households. Welfare gains for the poor are largely driven by the changes in the non-export agricultural sector in which they are engaged. This suggests that if the poor are to gain from policy reform, the dismantling of the anti-agricultural bias which largely prevailed in the pre-liberalised economy is fundamental. **Exchange rate, exports and imports:** The decrease in tariffs over the period 1998 and 2000 leads to an increase in imports. The increase in imports has two effects: First, export sectors are able to access cheaper imported intermediate inputs, causing exports to increase. Secondly, the increase in imports causes a depreciation of the exchange rate increasing export competitiveness which stimulates an increase in exports.

Source: Compiled by author.

Table 3.5.1 Applicability of CGE Modeling in Uganda: A Review of the Literature Cont'd

Author/s	Title of Study	Methodology and Data	Simulations Performed	Main Findings
Mbabazi Jennifer (2002).	A CGE Analysis of the Short-run Welfare Effects of Tariff Liberalisation in Uganda.	**Tariff rates:** Tariffs in the 1992 are derived from Uganda's 1992 Social Accounting Matrix and are computed as the ratio of imports at domestic prices to imports at world prices less 1 and are applied to 28 tradable sectors with an average of 13.7. The bulk of the tariffs were on sugar manufacturing at 21.5 per cent followed by the manufacturing sector with an average of 18 per cent. The highest single sector tariff was on the chemical products (classified under manufactures) which also had the highest proportion of imports. The food manufactures sector's tariffs were about 9 percent. The non-tradable agriculture sector and the export sector attracted the lowest tariffs.		**Impact on government transfers.** The period 1996–98 sees a reduction in tax revenue. Recall that a substantial share (20 per cent) of government revenue is derived from import tariffs. So, the reduction in import duties that is not compensated by increased revenue from wider import tax base results in lower tax revenue which in turn results in lower transfers negatively impacting the households that are heavily reliant on them as is the case in 1996–1998. **Impact on GDP** There are only marginal changes (ranging from a 2% -to 3% incease in GDP over the period of investigation. When tariffs are reduced between 1995 and 1998, GDP falls and only begins to rise after 1998. It stabilises in the post 1999 period when tariff rates are more or less stable. **Summary** The results from this paper have demonstrated that trade liberalisation is not a quick fix to developing country problems. It should be complemented by other policies in order to maximise household welfare. On the other hand, there are only minimal welfare gains households engaged in agriculture. Transfers (both government and inter-household) transfers and exchange rates play an important role determining household welfare outcomes.

Source: Compiled by author.

Table 3.5.1 Applicability of CGE Modeling in Uganda: A Review of the Literature Cont'd

Author/s	Title of Study	Methodology and Data	Simulations Performed	Main Findings
Anderson, Kym and Van der Mensbrugghe (2007).	Effects of Multilateral and Preferential Trade Policy Reform in Africa: The Case of Uganda.	The share of Uganda's trade in GDP is small partly because the country is land locked by other low income countries with identical trade patterns despite being a member of the Common Market for Eastern and Southern Africa (COMESA), a free trade area of 19 countries with ambitions to become a customs union, and the customs union of the East African Community (EAC). This paper tries to find out by how much trade and welfare would change in Uganda under various scenarios involving unilateral, preferential, and global trade reforms. **The global CGE model and protection data base** The model used for this analysis is the World Bank's global computable general equilibrium (CGE) model known as LINKAGE (van der Mensbrugghe, 2005). It is a relatively straightforward CGE model but with some characteristics that distinguish it from standard comparative static CGE models such as the GTAP model (Hertel, 1997). The model is recursive. Its base year is 2001 but can it be solved annually through 2015. The dynamics are driven by exogenous population and labour supply growth, savings-driven capital accumulation, and labour-augmenting technological progress. In any given year, factor stocks are fixed. Producers minimize costs subject to constant returns to scale production technology and consumers maximize utility, and all markets including for labour are cleared with flexible prices.	**Scenario 1:** Market and welfare impacts of current protectionist policies. **Scenario 2:** Welfare impacts of global full merchandise trade reform.	**Scenario 1 Results:** –Until a decade ago, Uganda was primarily an agrarian economy. With the opening of the economy, Uganda's has been given preferential access to rich country markets. As a result, the trade pattern has changed. The share of agriculture exports in total merchandise trade is now less than two-thirds. Manufacturing and processed food products contributed 36 percent in total merchandise exports. –Imports dominated by manufactured goods (47%) and commercial services (36%). Most trade is with neighbouring countries in Eastern and Southern Africa. –Significant trading with European Union members. **Simulation 2 Results** –In a freely trading world, Uganda's total output would be only slightly larger (0.2 per cent) but its trade volume would be about 5 per cent larger. More striking would be the change in the composition of its output and trade. –Overall agricultural output would remain almost unchanged but sector specific outputs would be smaller (i.e. sugar, meats, grains) and others larger (i.e. cotton, other crops, dairy products). Textiles and clothing also would be smaller, and the services sector larger. –The difference in outputs is partly due to Uganda's low own-country tariffs, and the fact that the tariffs faced by its exporters are nearly all zero into EU and US markets where Uganda exports more than two thirds of her total exports. –Therefore, trade reform by key trading partners leads to preference erosion for Uganda, which helps explain the impact on sugar, textiles, and clothing. **Scenario 2: Effect on bilateral trade** The direction of trade would be somewhat different under global free trade, with more exports to developing countries and less to preference-providing EU and US markets. Also, fewer imports would come from the EU and US in that scenario.

Source: Compiled by author.

Table 3.5.1 Applicability of CGE Modeling in Uganda: A Review of the Literature Cont’d

Author/s	Title of Study	Methodology and Data	Simulations Performed cont'd	Main Findings cont’d
Anderson, Kym and Van der Mensbrugghe (2007).	Effects of Multilateral and preferential trade policy reform in Africa: The Case of Uganda.		**Scenarios 2 cont'd** Welfare impacts of global full merchandise trade reform.	**Effect on real incomes** –Uganda would experience a slight decline in real national income. In Uganda’s case it would be by 0.3%, in contrast to a 1.4% gain on average for the rest of Sub-Saharan Africa. The majority of that small loss in national income is due to deterioration in Uganda’s terms of trade. Export prices on average decline by 2.6%, more than offsetting the 0.3% average decline in import prices. –The decline in export prices is fairly uniform across all main export sectors, while the increase in import prices is concentrated in dairy and sugar. These are highly protected in the rest of the world and their international price would rise substantially if the event of global free trade. However, the estimated export price declines for almost all sectors reduce Uganda’s welfare in this full global liberalization scenario. **Effect on sectoral value added**: The percentage change in value added is close to zero. The growth in value added of services is almost equal to the decline in value added in goods sectors. There are losers and gainers within each of the goods sectors.

Source: Compiled by author.

Table 3.5.1 Applicability of CGE Modeling in Uganda: A Review of the Literature Cont'd

Author/s	Title of Study	Methodology and Data	Simulations Performed	Main Findings cont'd
Anderson, Kym and Van der Mensbrugghe (2007).	Effects of Multilateral and preferential trade policy reform in Africa: The Case of Uganda.		**Scenarios 3:** Welfare Impacts of Multilateral Partial Reform under WTO's Doha Round.	**Scenario 3: Welfare effects**: –The decline in the average of Uganda's export prices is much less than in the full reform scenario, but import prices rise slightly because of the large increase in meat and sugar prices in global markets. The dollar contribution to Uganda's welfare from the decline in the terms of trade is only two-thirds as large in this partial reform case as in the case of full global liberalisation. Meanwhile, the decline in value added is only two-thirds that from global full trade reform. –The composition of sectoral output differs between full free form and Doha partial agreement. Specifically, there is much switching from manufacturing to services in this scenario, and there is almost no decline in the textile and clothing subsector.
			Scenario 4: Welfare Effects of Economic Partnership Agreements with the EU.	**Scenario 4 Results** The welfare effects are close to zero for Uganda. This is due to its relatively low tariffs and its relatively unrestricted access to EU markets in contrast to a considerable gain for ACP developing countries' as a group. And like Uganda, the ACP member countries perform slightly better under these EPA agreements than under the Doha scenario. In Uganda's case, this is because of less decline in their terms of trade, while for other ACP countries it is because of a bigger terms of trade improvement.

Source: Compiled by author.

Although we do not measure poverty in this dissertation using the traditional poverty measures such as the poverty headcount and poverty gap[17], we improve on the above studies by adopting a SAM multiplier model to identify Uganda's key sectors and analyse the effects of exogenous changes and policies. We infer on poverty using the changes in welfare (equivalent and compensating variation as percentage of GDP), household income distribution, and employment relative to the base year that arise due to exogenous changes and policies. Exogenous changes and policies that increase household welfare, reduce inequality and increase household income are said to have a direct bearing on poverty alleviation.

3.6 Merits and De-merits of CGE Models

The popularity and use of CGE models in analysing the impact of exogenous changes and policy shocks on the socioeconomic system is because of their advantages. First, the sectoral and institutional set up in the CGE model provides for a detailed analysis of the impact of various policies that is typically impossible with macro econometric models. Secondly, CGE models are advantageous over partial equilibrium models in that they provide an economy-wide assessment of policies, including the concurrent effects of policy changes and exogenous shocks on production, employment, poverty and inequality (Hertel, 1985; Devaranjan *et a*l., 2002). CGE models are solved numerically, providing the magnitude and direction of the impact of policies; there are built with a strong foundation of microeconomics, enabling the modeler to explain the results of simulations using simple economic concepts. In addition, compared to macro econometric models, the specification of demand and supply functions in CGE models is completely consistent with the underlying theories of optimising behaviour of economic agents. In econometric

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[17] Poverty gap is the mean shortfall from the poverty line (counting the non-poor as having zero shortfall), expressed as a percentage of the poverty line.

models, the role of optimizing theories of the behaviour of individual actors is usually restricted to that of suggesting variables to be used in regression analysis.

Further, CGE models are a better representation of real economies than their linear predecessors (i.e. these models escape the constraints of linearity often associated with SAM multiplier and partial equilibrium models). Due to inadequate or sometimes unreliable data, CGE models become an appropriate tool for measuring the effects of policy shifts and external shocks which are difficult to measure using traditional econometric models (De Melo, 1988). On the other hand, CGE models are explicitly structural and do not encounter the identification problem associated with partial equilibrium analysis.

Finally, CGE models use the SAM as their data base. This makes it easier to study the impact of exogenous changes on individual sectors and agents of the economy all of which are captured as accounts or entries of the SAM. That is, the SAM provides a disaggregation of households, factors, and other accounts providing the modeler, the flexibility to analyse the impact of external shocks on household welfare, factor incomes, and employment.

The use of CGE models to study the impact of trade liberalization is based on their ability to integrate micro and macro elements of structural adjustment programs, especially where liberalization affects the structure of trade and real exchange rates (Devarajan and Robinson, 2002). CGE models can also provide simple and easy to communicate lessons about adjustment policy. For example, formulas used in computing real exchange rate depreciation as result of a terms of trade shock (Devarajan *et al*., 1993).

However, the use of CGE models in policy analysis is not without limitations (Thurlow, 2002). The main criticism of CGE models is inherent in their traditional formulation which is tied to the Walrasian ideal of equilibrium in all markets (Dervis *et al.*, 1982). However, in pure neoclassical setting, producers and consumers might react passively to price changes to determine their demand and supply schedules. Markets are therefore assumed to clear through the interaction of relative prices such that equilibrium is achieved in both the goods and factor markets. The model does not take into account market imperfections which might prevent the market from clearing and as such the equilibrium price might not exist. In addition, while static CGE models are useful in determining the overall effect of policies after the full adjustment process has been allowed to take its course, these models cannot provide insight into the costs of the adjustment or how long these adjustments may take to complete themselves.

There is a real lack of understanding of how sensitive CGE simulation results are to the selection or calibration of the parameters in the model. Similarly, there is considerable debate in CGE literature regarding the effectiveness of calibrating CGE models to a benchmark year data set (Partridge and Rickman, 1998, p.228). The argument being that reliance on one-year' worth of data is under-identified. This means that there is too little data to assign values to too many parameters making the resulting calibrations unreliable.

A fundamental problem in analyzing the impacts of structural reforms using CGE modeling is the complexity of integrating micro and macro aspects in a single model (Devaranjan *et al*., 2002). In addition, static CGE models based on the assumptions that all markets clear in a single period and limited only to the determination of relative prices may not be appropriate in the analysis of the effects of policy shocks. Such models can operate only in the short-run. In cases where structural adjustment is accompanied by financial market crises which operate through product and factor markets in the long-run, a dynamic model is suitable for policy analysis (Devaranjan *et al*., 2002).

Finally, most CGE models do not explicitly incorporate the workings of the financial sector (Peterson, 2003). This is true because most studies that use the CGE modeling framework do not include variables such as the interest rate and money supply. Therefore, the analysis of the effects of exogenous changes and policy shocks is performed under the implicit assumption that the monetary sector passively adjusts to facilitate the observed changes in the real economy (Thurlow and Seventer, 2002). For example, changes in interest rates necessary to induce changes in savings and investments are made without the explicit modeling of the market for loanable funds. Even though the omission of the financial sector in CGE models does not affect the conclusions made regarding the real economy, it limits the use of such models from assessing the full effects of policies on the real sector (Thurlow and Seventer, 2002). The explicit inclusion of the financial sector is therefore an important aspect of CGE modeling if we are to understand the full effects of interest rates and inflation on the real economy during simulations with CGE models (Thurlow and Seventer, 2002).

3.7 Objectives of the Study

The principle objective of this study is to identify sources for growth and poverty alleviation in Uganda. That is, to identify key sectors and policies that that significantly increases real GDP and welfare (i.e. policies that not only increases national output but also generate significant redistribution of welfare). The increase in welfare and the inference on poverty alleviation are based on the impact of each policy on factor employment, and household and factor incomes. We achieve this by using the SAM multiplier and computer general equilibrium model. In addition, following alternatives policies and exogenous shocks, the identified sectors can play a significant role in Uganda's quest for growth and poverty reduction.

The specific objectives are: a) To review the performance of the key sectors of the economy; b). To analyze the structural characteristics of Uganda’s economy based on the Social Accounting Matrix and their implications on growth and poverty reduction prospects; c) To analyze the impact of selected policy experiments on institutional and factor incomes; employment, welfare and inequality; identify and propose sectors that policy interventions should target to have a lasting impact on growth and poverty alleviation; d) To identify which households and sectors are mostly affected by external shocks and policies and what should policy makers do to address regional imbalances.

3.7.1 Main and Specific Research Questions

The main research question this dissertation seeks to address is: What are the sources of growth and poverty reduction in Uganda? The specific questions are: (a) what are Uganda’s key sectors? That is, which sectors are associated with significant forward and backward linkages? (b) What is the magnitude and direction of the impact of exogenous changes on selected economic variables? (c) What is the impact of selected exogenous changes and policy shocks on inequality and welfare and which households are mostly affected by these changes? (d) Given that poverty in Uganda is predominantly a rural phenomenon, which policies should be implemented in these areas to significantly improve household welfare? That is, which policies could significantly increase household welfare, employment, and household incomes in rural and urban areas?

3.8 Research Contribution and Significance of the Study

This dissertation undertakes the construction of a single country Social Accounting Multiplier based CGE model for Uganda. Unlike previous studies, the SAM multiplier decomposition technique has not been used in any welfare distributional analyses for Uganda. This study improves previous studies (See Table

3.5.1) in various ways: First, we use the SAM multiplier model to identify Uganda's key sectors[18]. It is hypothesised that the identified key sectors would guide policy makers to formulate and implement policies to enhance economic growth and alleviate poverty in Uganda. Secondly, using the SAM multiplier decomposition results, we rank and identify sectors that generate significant employment and household incomes if such sectors were to experience a unit increase in final demand. It should be noted that increasing household incomes and employment form the basis for alleviating poverty in Uganda.

The multiplier decomposition approach is important for distributional policy analysis, as it separately captures the direct and indirect impacts of policy shocks by examining the nature of linkages in the economy associated with these outcomes (Thurlow and Dorosh, 2009; and Nganou, 2005). In fact, the decomposition is important in several respects, not the least of which is its ability to separate the aggregate impact of a shock into three individual effects namely, transfer effects, spillover effects and, closed loop effects.

The specific contributions of this study can be summarized as follows: (a) the detailed analysis of multipliers and sectoral linkages is an important tool that will allow policy makers to stimulate (or to provide incentives) to a strategic sector, mindful of the fact that spill-over effects will propagate to other sectors. For example, given the strong forward and backward linkages between agriculture and industry, policies that aim at increasing agricultural productivity (i.e. training of workers and providing marketing incentives and free inputs among others) will have a direct impact on the productivity and output of the manufacturing sector; (b) The effects of external shocks and policies on household welfare and inequality can guide policy makers to implement pro-poor growth policies (i.e. policy makers will focus on

[18] Key sectors have forward and backward linkages greater than unity. They contribute significantly to household income and and factor employment.

regions and sectors that are adversely affected by these changes thereby allocating resources efficiently since they would be able to quantify the effects of interventions due to changes in these resources); (c) Lastly, this study is expected to contribute to the qualitative and quantitative research framework that is important for ex ante policy reforms and analysis, thus guiding other studies on how to design policies for growth and poverty alleviation in Uganda.

3.9 Conclusion

This chapter was intended to achieve two objectives: First, to give a detailed discussion of the methodology that will be used to answer the research questions; and to provide a comprehensive review of the SAM and CGE models, from which this dissertation makes a research contribution. The research contribution of this study stems from the fact that this is the first study to use the SAM multiplier decomposition to identify Uganda's key sectors and to use the CGE modeling framework to analyse the effects of exogenous changes and policy shocks on income distribution, inequality, and welfare in Uganda. In addition, we make use of two realistic assumptions with regard to the labour market and incorporate them in the CGE model for Uganda. We assume that unskilled and low skilled labour is unemployed and mobile. This is because Uganda like any developing country has surplus labour (unemployment). In addition, we assume high skilled labour is mobile and fully employed. This is due to the acute shortage of skills common in developing countries. In addition, the SAM multiplier decomposition and CGE model used in this study is the first of its kind to determine key sectors and growth prospects for Uganda. In the next chapter, the salient features of Uganda's economy are discussed.

Chapter 4

A Social Accounting Matrix for Uganda

4.1 Introduction and Motivation

The main purpose of this chapter is to contribute to the understanding of Social Accounting Matrices (SAM) in general and the format of the SAM for Uganda. The SAM is a comprehensive, disaggregated, consistent, and complete data system that captures the interdependence that exists within a socioeconomic system (Decaluwe *et al*., 1999; Thurlow *et al*., 2009; Pyatt, 1988); it can also be defined as a consistent set of accounts that quantifies the economic flows involving production, incomes, and expenditures during a given period of time. Alternatively, the SAM can be defined as a square matrix consisting of the row and column accounts that represent the different sectors, agents, and institutions of an economy at the desired level of disaggregation (Chung-I Li, 2002). Each account in the SAM is represented by one row and one column of the table and each cell shows the expenditure by the column account and income to the row account. Based on the principle of double-entry accounting, the total revenue (row total) must be equal to total expenditure (column total) for each account in the SAM. Similarly, a SAM can be defined as a useful framework for preparing consistent, multi-sectoral, economic data that integrates national income, input-output, flow of funds, and foreign trade statistics into a comprehensive and consistent dataset. SAM can also be defined as a tabular presentation of the accounting identities of the economy in which incomings are equal to outgoings for all the sectors that comprise the SAM (Taylor, 1983). A SAM is usually prepared for a given year and provides a static image or snapshot of the structure of country's economy (King, 1988). A well-constructed and balanced SAM can be used as data base for Computable General Equilibrium (CGE) models. That is, CGE models are calibrated to the SAM.

The SAM lays down the factorial income by production activities and its distribution between social and institutional groups. Thus, depending on the classification scheme used to record transactions and the extent of disaggregation, the SAM can provide useful information on key issues such as inter-sectoral linkages (i.e. linkages between agriculture and industry), interregional flows within an economy, the determination of income distribution by socioeconomic groups given the structure and technology of production and the resource endowments of these groups, and the relationship between different regions within an economy, and with the rest of the world. Finally, the SAM can be used as conceptual framework and a basis for modelling to explore the impact of exogenous changes on such variables as exports, certain categories of government expenditures, and investment on the interdependent socioeconomic system, e.g. the effects of exogenous changes on the structure of production, factorial, and household income distributions (De Melo, 1988).

Further, the SAM explicitly breaks down households into relatively homogeneous socioeconomic categories that are recognised for policy purposes and exhibit relatively stable characteristics (Decaluwe *et al*., 1999). This type of disaggregation allows the SAM to be used in the analysis of the effects of government policies on poverty and income distribution. A disaggregated SAM is useful in the study of the aggregate effect of a shock since it indicates the contribution of inter-industry relations and other accounts in the total impact of a shock (Nganou, 2005; Pyatt and Round, 1977 and 1979; Dervis *et al*., 1982).

Generally, the main reasons for using the SAM or input-output framework in statistical work and economic analyses can be summarized below.

The SAM provides a conceptual and coherent framework for the integration of disaggregated production data with respect to outputs and inputs, and of disaggregated data on goods and services with respect to origin (supply) and destination (use); the SAM acts as a tool to test the coherence, consistency and quality of the various censuses and surveys for various sectors in the economy (i.e. agriculture, industry and manufacturing, services, trade etc.,), system of National Accounts (SNA), surveys, censuses and other relevant information. This in turn yields a database, which is used in the analysis of a country's socioeconomic and production structure; its relationships to the formation of factorial income (value added) and final demand and institutions; and, in a more comprehensive way, in the analysis of interactions regarding economic growth, employment generation, factorial and institutional income distribution, and price formation.

With respect to the development process, the use of the SAM multiplier and CGE models lead to a better understanding of production and price effects, institutional income distribution and their relationship with the domestic environment and with the rest of the world all within the context of policy formulation (Alcorn *et al*., 1986, 1991, 2006).

4.1.1 The SAM and Input-Output Table

Unlike input-output tables which show only inter-industry flows in an economy, the SAM includes both social and economic data for all economic agents and sectors. The data for the SAM is collected from input-output tables, national income statistics, and household income and expenditure statistics. Thus, the SAM is broader than an input-output table and a national account. It gives a detailed and consistent listing of all the transactions within an economy. An input-output table records economic transactions alone irrespective of the social background of the transactors. On the other hand, the SAM shows a classification of various institutions to their socioeconomic backgrounds instead of their economic or functional activities (Chowdhury and Kirkpatrick, 1994).

4.2 The Uganda SAM and Collaborating Institutions

The 2002 Uganda SAM was constructed by three collaborating institutions. That is: the Institute for Social Studies (ISS) in the Netherlands, the Uganda Bureau of Statistics (UBOS), and the Economic Policy Research Centre (Alarcon *et al*., 2006). The construction of the SAM for Uganda was motivated by the data evaluation exercise that took place in February 2005. Data used to construct the SAM included: The 1999/2000 and 2002/2003 Uganda National Household Surveys (UNHS), the 2000/2001 Uganda Business Inquiry, and the 2002 Supply and Use Table constructed by the IMF. First, an input-output table (known here as the basic SAM) was constructed for which output was valued at purchaser prices and then at producer prices after constructing the matrices for trade and transport margins. In the supply table, flows of goods and services are valued at basic prices. In the use table, the flows are valued at purchasers' prices. In order to attain identities between Supply and Use, trade and transport margins and taxes less subsidies on products were added to the supply table. The total of trade margins by product is equal to the total of trade margins by the trade industries and the secondary trade margins by other industries. An analogous equation holds for the transport margins which include transportation costs paid separately by the purchaser and included in the use of products at purchasers' prices.

After the aggregation and with the help of Leontief coefficients, a final SAM was constructed and its entries measured at producer prices. The original schematic framework is a 193 by 193 matrix and has 61 commodities, 74 activities, and 22 factors of production, 32 household types, 1 government, 1 Enterprise/Firm, 1capital account, and the rest of the world account. The structure of the typical macro SAM is presented as Table 4.2.1 below.

Table 4.2.1 The Structure of the Macro SAM

	Act's	Com'ds	Factors	Firms	H'holds	Government	Capital (S-I)	Rest of the world	Total
Activities		Domestic supply							Activity income
Commod's	Intermediate demand				household consump spending	Gov't Consump	Investment Expenditure	Exports earnings	Total demand
Factors	Value added								Total factor income
Firm			Capital income		Interest/ insurance payments			Distributed income from RoW	Total Firm income
Households			Factor payments to H'holds			Transfers		Foreign Remittances	Total hhd income
Government	activity taxes	Import tariffs	Factor income paid to gov't	Corporate taxes	Direct taxes			Foreign grants	Total government income
Capital (S-I)				Corp saving	Household saving	Government saving/fiscal surplus		Current account balance	Total Savings
Rest of the world		Import payt's		Enterprise income paid to ROW			Net invest. abroad		Total foreign exchange outlays
Total	Gross output/total cost of production	Total Supply /absorption	Total Value Added	Total Enterprise. Expend	Total hhd Expend	Total Govt Expend	Total investment	Total forex earnings	

Source: Chung-Li, J. (2002); Thorbecke (1988); Breisinger, C., M. Thomas, and J. Thurlow (2009).

It should be noted that the consolidated SAM was compiled following the principles and practices of the 1963 United Nations System of National Accounts (SNA). The macro SAM was constructed based on the standard framework of the International Food Policy Research Centre (IFPRI) and the format by Thorbecke (1988). It is important to note that the disaggregated SAM used in this dissertation is a 44 by 44 matrix with 10 commodities, 10 activities, 9 factors, 11 institutions, and 3 tax accounts, and 1 capital account (See Appendix C).

Five major accounts are described in the 2002 Uganda SAM. These are: activities; commodities, factors of production; institutions (including the rest of the world) and capital (savings and investment) account. Distinction is made between production activities (the entities that carry out production) and commodities. Commodities represent both activity outputs, which are either sold domestically or exported to the rest of the world, and imports. Despite the fact that the SAM was aggregated in such a way that the number of activities is equal to the number of commodities, the distinction of activity-commodity was maintained. The receipts of the 2002 Uganda SAM are valued at producer prices in the activity accounts and at market prices including indirect commodity taxes) in the commodity accounts (Lofgren *et al*., 2002). Payments are made in the commodity accounts to domestic activities, domestic indirect commodity taxes and imports, direct tax accounts, and the rest of the world. This treatment of commodity accounts gives the flexibility to model imports and domestic output as imperfect substitutes using the CES function (Armington assumption) or as perfect substitutes (Lofgren *et al*., 2002).

4.2.2 Classification of Accounts in the SAM

Classification of Factors

For the complete SAM, factors of production were disaggregated by education level, gender, and location (Table 4.2.2). This disaggregation corresponds to the need to capture the most important characteristics on the factor participating in the production process and how this factor benefits from this participation. In addition, the disaggregation of factors is critical in analysing the distributional impacts of various government policies on household welfare. The mapping of factor income to households ensures that changes in production activities are reflected in changes in household income levels.

Four types of labour skills were identified. These are (a) unskilled; (b) semi-skilled; (c) skilled; and, (d) high skilled. In order to disaggregate the factors of production account, use was made of a primary breakdown into wage labour income (compensation of employees) and other primary factor income. With regard to wage labour income, a further classification based on the following criteria was employed.

(a) Rural – Urban,

(b) Male – Female,

(c) Unskilled – Semi-skilled – Skilled – High-skilled.

This gave rise to 16 labour types (2x2x4). The definition of unskilled, semi-skilled, skilled, and high-skilled is linked to educational achievement:

(a) Unskilled: not completed primary

(b) Semi-skilled: completed primary (completed primary seven)

(c) Skilled: above primary to completed secondary (inclusive)

(d) High-skilled: graduate from tertiary education (above completed secondary).

In the SAM used in this dissertation, the unskilled, semi-skilled labour type was further aggregated to give the low skilled category and the skilled and high skilled categories aggregated to generate the high skilled labour. This adjustment generated 8 labour types by skill, location and gender (Table 4.2.2).

Table 4.2.2 Classification of Labour

	Skill Category	Residence	Gender
1	Low Skilled	Rural	Male
2	Low Skilled	Rural	Female
3	Low Skilled	Urban	Male
4	Low Skilled	Urban	Female
5	High Skilled	Rural	Male
6	High Skilled	Rural	Female
7	High Skilled	Urban	Male
8	High Skilled	Urban	Female

Source: Compiled by author: 2002 Uganda SAM

Classification of Households

Studies have shown that that it is important to incorporate country specific features when analysing the impact of various policies (Dorosh and Sahn 2000). The SAM used in this dissertation is disaggregated taking into account the activities where households participate and the regions where they live. The household account is disaggregated into 8 household groups by region and residence to reflect the impact of policies on household welfare.

Households were further classified based on their ownership of land, which is a key factor of production. For example, Appleton (2001) found that regional disparities are partly due to land ownership. He found that central and western based households were relatively better off than the eastern or northern based households because of land ownership and participation in agriculture. It should also be noted that the disaggregation of the household account is guided by the policy focus of the research questions being investigated (Dorosh and Sahn 2000).

Because poverty and income inequality are closely linked to geographical location of households groups, households were further disaggregated based on quintiles chosen by taking into account a detailed analysis of the poorer regions in Uganda and in line with the country's overall poverty reduction strategy (Poverty Eradication Action Plan, 1997/2000). Another advantage of the explicit inclusion of the regional dimension into the SAM modelling framework is that most often policies tend to be location specific. These policies might include increased government expenditure on services (i.e. education and health); and price policies with respect to commodities and inputs to the extent that the production of certain commodities are region specific (Thorbecke, 2000). 32 households groups were generated, that is 8 household categories in four geographical regions (Table 4.2.3).

Table 4.2.3 Classification of Households

	Residence	
Region	Urban	Rural
Central	Central Urban Households	Central Rural Households
Eastern	Eastern Urban Households	Eastern Rural Households
Northern	Northern Urban Households	Northern Rural Households
Western	Western Urban Households	Western Rural Households

Source: Compiled by author: 2002 Uganda SAM.

The Firms/Enterprise Account

The 2002 Uganda SAM has one firm account. Firms' income includes only capital income, which is the allocation of operating surplus by activities to firms. This income is balanced with payments by the enterprise to households in terms of dividend, direct taxes paid (corporate taxes), and transfers to the rest of the world. The remaining proportion of firms' income is saved.

Government Account

The core government account specifically includes transfers and government expenditures on final goods and services. The standard IFPRI CGE model framework does not provide for direct tax transfers to the core government account. Therefore, government income is from taxes collected by the special tax accounts. The taxes are then transferred to the core government account as revenue. On the expenditure side, the 2002 SAM shows that government purchased final goods and services from the commodities account and paid transfers to non-governmental institutions, and the rest of the world). The remaining proportion of government income is saved.

Tax Collection Accounts

In the 2002 Uganda SAM, three tax accounts were introduced. These are: taxes on production activities, import duties (taxes on commodities) and value added taxes. Direct taxes are levied on payments to capital (capital income), households (income tax), and enterprises (corporate taxes). The remaining taxes were collected from commodity accounts (sales tax or value added tax). Tax revenues from all accounts are added and made available as income to the core government account.

Savings-Investment Account or the Capital Account

This is a critical account given its linkage with the real sectors of the economy. Due to lack of data, the capital account could not be opened and was presented in a consolidated manner and calculated assuming a simple and stable savings function for household classes depending on the level of income (Alarcon *et al.*, 2006). The aggregated capital account shows that gross savings are used to finance total investment expenditures that are made by firms in the commodities market. The receipts of this account include savings by households, corporations, the government, and the consumption of fixed capital and foreign savings (current account balance). The columns of the capital account represent the savings that are available to buy capital goods (investment) from commodity accounts. Following the double entry accounting principle, the total value of gross savings must be equal to the total value of gross investment.

The Rest of the World Account

In its dealings with the rest of the world, Uganda receives transfers in form of remittances, and grants. These transfers are fixed in foreign currency. In addition, Uganda imports goods and services from and sells goods and services (exports) to the rest of the world. The rows of this account show Uganda's total income spent abroad, which consists of factor income transfers, and other institutional transfers to the rest of the world. The columns of this account records Uganda's total foreign earnings from the rest of the world, and includes earnings from exports, and transfers to domestic institutions (e.g., workers remittances and grants), transfer to households and government, and foreign savings (current account balance) in the saving-investment or capital account.

4.3 Detailed Description of the Macro SAM: Selected Entries

In this section, we discuss the entries and identify where information can be usually found to a construct a more disaggregated SAM. Cell entries are identified as row-column combinations and are valued in millions of Uganda shillings at 2002 prices. The macro SAM for Uganda is presented as Table 4.3.1 below.

Value Added

[Factors, Activities: 10,062,458]

Total value added is the earnings received by the factors of production, such as wages and salaries paid to labour, and profits paid to capital. Total value added is also called GDP at factor cost. Although value added is a single figure in the macro-SAM, it is allocated to labour which is disaggregated based on skill, gender and location. This disaggregation of value added is important in determining distributional impact of policies.

Table 4.3.1 The Uganda Consolidated SAM, 2002 at Producer Prices (Uganda Million Shillings)

Incomings/outgoings	Commod's	Activities	Factors	Domestic Institutions			Consolid. Capital Account	RoW	Totals
	(61)	(74)	(22)	H'hold (32)	Firm (1)	Gov't (1)	(1)	(1)	
Commod's (61)		Intermed. Consump. 7,774,738		H'hold Consump. Expend 8,991,685		Gov't Consump. 1,808,821	Investment demand/gross Capital formation 2,420,211	Exports of Goods and Services 1,514,289	Total demand 22,509,744
Activities (74)	Domestic production 18,710,605								Activity income 18,710,605
Factors of Production (22)		Value Added 10,062,458							Total Factor Income 10,062,458
Households (32)			Employ't and mixed income 7,835,800	Transfers btn hhds 1,219,686	Interest/Insurance payments 1,667,507	Transfers 70,364		Workers Remittances 668,954	Total Household Income 11,462,312
Firm (1)			Operating surplus/ mixed income 2,143,282	Non-factor income 14,030	Distr. Fact. & Non- 190,852	Transfers 98,726		Dist Factor income from RoW 125,924	Total Enterprise Income 2,572,813
Govt (1)	Indirect tax/Import taxes 849,058	Indirect tax/prod'n taxes 352,639		Direct taxes 158,251	Direct/corporate taxes 130,921			Foreign Grants 1,080,258	Total Gov't Income 2,571,127
Consolidated Capital Account (1)		Activity savings/profit 520,770		Household Savings 500,000	Corporate Savings 382,989	Government Savings 537,970			Total Savings 1,941,729
RoW (1)	Imports of goods and services 2,950,080		Component. of employ't to Rest of world 83,376	Factor and Non-Factor income to Rest of world 578,659	Factor Income to Rest of world 200,545	Distr. Fact. & Non-factor income to rest of world 55,247	Net Lending to rest of world -478,483		Total Foreign Exchange outlays 3,389,424
	Total supply/absorption 22,509,744	Gross output 18,710,605	Total factor spending 10,062,458	Total Household spending 11,462,312	Total Enterprise spending 2,572,814	Total Gov't spending 2,571,128	Total Investment spending 1,941,729	Total foreign exchange earnings 3,389,424	

Source: Alarcon *et al*., (2006).

Intermediate Demand

[*Commodities, Activities*: *7,774,738*]

Intermediate demand is the goods and services used in the production process. The SAM for Uganda is more detailed and disaggregated across commodities revealing each sectors production technologies (i.e. which sectors use more input per unit output). This information is useful when determining the effects of policies and external shocks on the economy.

Factor Income Distribution

[*Households, Factors: 7,835,800; [Firm, Factors: 2,143,282]; [RoW, Factors: 83,376]*

Factor incomes in the macro-SAM were paid to households, firms and the rest of the world account. In the SAM, households are disaggregated into different household groups (i.e. by location and gender). This information allows us to assess distributional impacts from policies. As a simple example, if our SAM shows that low-income households rely more on labour earnings than higher-income households, then policies that increase production in labour-intensive sectors should disproportionately benefit poorer households. The discussion of factor income distribution is important because policy shocks from simulations cause changes in relative prices of commodities, which in turn impact on factor use, factor prices and factor incomes, and subsequently affecting household welfare (Mbabazi, 2002).

Domestic Production

[Activities, commodities: 18,710,605]

Domestic production is the sum of all the marketed by all activities which is net of marketing and transport margins.

Private Consumption

[Commodities, Households: 8,991,685]

Households use most of their incomes to purchase commodities for consumption. Although the macro-SAM contains a single entry, the SAM used in this dissertation disaggregates private consumption across different commodities and household groups. This disaggregation is important because household's consumption patterns vary, especially across income groups. For example, poorer households usually spend a larger share of their income on food items than do wealthier households, and so changes in the supply of these commodities will affect poorer households more. These differences can influence the distributional impacts of policies and external shocks.

Government Recurrent Expenditure and Investment Demand

[Commodities, Government: 1,808,821] and [Commodities, Investment: 2,420,211]

Public consumption or recurrent expenditure consists of the goods and services purchased to maintain government function. These include: spending on defence and public service salaries. Investment demand consists of both public and private gross capital formation, such as spending on roads, schools, and residential housing.

Remittances and Social Transfers

[Households, Government: 70,364] and [Households, Rest of the world: 668,954]

Apart from factor payments, households also receive transfers from the government and the rest of the world. Government transfers include social security payments and public pensions. Foreign receipts usually include remittances from family members living and working abroad. Conversely, households might also remit incomes to family members living abroad. In the macro-SAM, this could be reflected as a positive entry in the cell [Rest of world, households].

Government Taxes

[Government, Commodities: 849,058]; [Government, Activities: 352,639]; Government, Households: 158,251]; and [Government, Enterprises: 130,921].

The government generates revenue from direct and indirect taxes. Direct taxes include personal (pay as you earn) and corporate taxes imposed on domestic institutions, such as households and enterprises. Indirect taxes include production taxes, and import duties. Taxes paid by enterprises include corporate income tax and tax on property; and net interest payments or transfers from enterprises to government.

Grants, Loans, and Interest on Foreign Debt

[Government, Rest of world: 1,080,832]

Uganda, like any other low-income country receives grants and loans from development partners and foreign financial institutions to cover recurrent spending and capital investments. These are direct payments from the rest of the world to the government. Conversely, foreign debt requires interest payments, which are positive payments from the government to the rest of the world.

Domestic Savings

[Savings, Activities: 520,770]; [Savings, Households: 500,000]; [Savings, Enterprise: 382,989]; and [Savings, Government: 537,970]

The difference between incomes and expenditures is savings (or dis-savings if expenditures exceed incomes). In the macro SAM for Uganda, producers, households, enterprises and government save. For activities or producers, this is equal to profits from production; for households and firms, savings is the difference between their incomes and expenditures. For the government account, savings is equal to the fiscal surplus if income exceeds expenditure and deficit if expenditures exceed incomes. Information on domestic private savings is rarely recorded in developing datasets. Therefore, private savings is often treated as a residual when balancing a macro-SAM.

Net Foreign Savings/Net lending

[Savings, Rest of world:-478,483]

This is recorded as the difference between foreign saving/investment at home and domestic saving/investment abroad. The negative figure indicates a net positive foreign investment at home.

4.4 Interpreting the Micro SAM

4.4.1 GDP Shares

By calculating the share of GDP generated by each sector, we are determining which sectors contributed the most to factors' income or value-added. Our findings show that Uganda depends heavily on agriculture, with the sector contributing about 27 percent to GDP at factor cost in 2002 (Table 4.4.1). Other Services (28 percent), Trade Service (11.8 percent), Construction (11.6 percent) and Health and Education (10 percent) also accounted for a larger share of GDP at factor cost. The most labour intensive sectors in the SAM are Agriculture, Trade Service, and Other Services. For example, 6.2 percent of Agriculture's value-added is paid to labour. By contrast, the most capital-intensive sectors in Uganda are Agriculture, Other Services, Construction, and Trade Services (Table 4.4.2). It should be noted that Agriculture is capital intensive for two reasons namely: Agriculture's share of mixed income is relatively high compared to other sectors (Table 4.4.3). Since mixed income is part of capital income, this makes agriculture more capital intensive. In the 2002 SAM, mixed income was allocated to household classes based on their shares of agricultural land holdings as weighting factors (Alcorn *et al*., 2006). This in turn made agriculture more capital intensive relative to other sectors. Together, these calculations describe the key structural characteristics of production in the economy.

Table 4.4.1 Sectoral Shares in Value Added/ GDP at Factor Cost

Sector	Value Added (UGX. Million)	Share in Value Added (%)
Agriculture	2,692,669	26.8
Mining	34,014	0.3
Food Processing	315,700	3.1
Manufacturing	113,004	1.1
Utilities	389,830	3.9
Construction	1,166,230	11.6
Trade Service	1,186,435	11.8
Transportation	335,138	3.3
Health and Education	1,007,824	10.0
Other Services	2,821,614	28.0
Total	*10,062,458*	*100*

Source: Own Computations. The 2002 Uganda SAM.

Table 4.4.2 Factorial Shares in Value Added (%)

Sector	Low skilled labour	High skilled labour	Mixed income	Operating surplus	Total share in value added
AGRI	5.3	0.9	20.3	0.33	26.8
MIN	0.1	0.00	0.26	0.01	0.3
PROC	0.7	0.5	0.63	1.31	3.1
MAN	0.4	0.7	(0.56)	0.59	1.1
ELEC	0.02	0.7	-	3.20	3.9
CONS	0.4	1.0	4.68	5.56	11.6
TRS	0.6	1.4	6.41	3.38	11.8
TRAN	0.3	0.3	0.25	2.50	3.3
HEAL	0.3	7.8	0.30	1.56	10
OTH	1.4	11.1	12.75	2.86	28
Total	*9.5*	*24.4*	*45*	*21.3*	*100*

Source: Computed by Author. 2002 Uganda SAM.

Table 4.4.3 Sectoral Distribution of Value Added (Million Uganda. Shillings), 2002

Sector	Labour income (A)	Mixed Income (B)	Operating surplus (C)	Total Value Added (A+B+C)	Capital Income (B+C)
AGRI	617,230	2,042,626 (45)	32,813	2,692,669	2,075,439 (31)
MIN	6,750	26,060	1,204	34,014	27,264 (0.4)
PROC	119,844	63,666	132,190	315,700	195,856 (2.9)
MAN	110,083	(56,707)	59,628	113,004	2,921(0.04)
ELEC	68,125	-	321,70	389,830	321,705 (4.8)
CONS	135,667	470,771	559,793	1,166,230	1,030,563 (15.5)
TRS	201,968	644,713	339,755	1,186,435	984,467 (14.8)
TRAN	58,541	24,939	251,658	335,138	276,597 (4.2)
HEAL	820,858	29,927	157,039	1,007,824	186,966 (2.8)
OTH	1,251,404	1,282,713	287,497	2,821,613	1,570,209 (23.5)
Total	*3,390,470*	*4,528,706*	*2,143,282*	*10,062,458*	*6,671,988*

Source: Computed by Author. 2002 Uganda SAM. For Capital income, values in parentheses represent the share of each sector in capital income. Note the share of agriculture's mixed income in totalmixed income (in parentheses).

4.4.3 Fixing Capital in Simulations: Implications on Sectoral Value Added

From the sectoral shares of value added above, it is clear that agriculture is more capital intensive partly because of its large share of mixed income. In performing simulations where capital is fixed to activities, this is bound to have implications on output of those sectors that are capital intensive (i.e. Trade Service, Construction, and Other Services). To fully account for the effects of restricting capital on sectoral value added and other economic variables, a sensitivity analysis is performed with an alternative closure rule for capital (i.e. capital is fully employed and mobile) and compare the outcomes with the activity specific capital closure rule. The results of the sensitivity analysis are presented in Table 7.14.4 and Table 7.14.5. When capital is fully employed, the change in sectoral value added for those sectors deemed capital intensive (i.e. agriculture, Construction, Trade Services, and Other

Services) is higher with the simulation of world export price (Table 7.14.4). For the remaining simulations, the outcomes are not all that straight forward.

4.4.4 Gross Output Shares

By calculating the share of each factor and commodity payment in the value of gross output (Table 4.4.4), we are determining the sectors' production technologies. In other words, we are calculating the amount of each input required to produce a unit of each sector's output. We found that, in Uganda, manufactured goods are among the most important intermediate input. In the Mining sector, for example, manufactured inputs account for 12 percent of the value of output. This means that for each 100 million shillings worth of Mining output, 12 million shillings must be spent on manufactured inputs. Manufactured inputs are also important for the production of manufactured goods themselves (52 percent), Food Processing (8.6 percent), Construction (27 percent), Transport (19 percent), and Trade Service (6.8 percent). Agriculture inputs are important in the production of Processed Foods and Manufactured goods. In turn, Trade Service and Transport services are key inputs for most sectors, especially Agriculture, Manufacturing, Construction and Other Services. In addition, low skilled labour is an important input in Agriculture. Apart from manufacturing, capital is an important input for most sectors. The treatment of mixed income is responsible for the low share of capital input in manufacturing. Mixed income was allocated to households based on land ownership as weighting factors, with agriculture taking the largest share (Table 4.4.3).

Table 4.4.4 Gross Output Shares (%)

Comm	AGRI	MIN_A	PROC_A	MAN_A	ELEC_A	CONS_A	TRS_A	TRAN_A	HEAL_A	OTH_A
AGRI_C	14.2		34.1	8.95					0.007	0.62
MIN_C		0.08	0.06	1.24		1.71				
PROC_C	0.89		18.9	3.46		0.03	1.55	0.82	0.11	0.76
MAN_C	3.88	12.3	8.6	51.7	5.75	27	6.86	18.8	12.21	6.49
ELEC_C	0.18	1.7	0.95	1.48	1.79	0.21	1.29	1.3	1.54	1.24
CONS_C	0.04	0.18	0.44	0.56	0	2.55	0.3	0.37	0.85	2.73
TRS_C	2.22	2.86	9.86	9.05	1.14	3.07	1.7	6	3.79	2.09
TRAN_C	1.48	0.24	2.73	3.25	0.23	3.25	8.24	1.13	1.36	2.81
HEAL_C	1.09	0.19	0.72	0.92	0.17	0.41	0.15	0.23	7.79	2.75
OTH_C	0.77	8.13	7.4	9.57	2.78	2.43	14.5	6.75	9.62	21.2
LS_RM	12.1	8.97	0.95	0.97	0.05	0.88	1.08	1.08	1.43	0.99
LS_RF	1.89	1.05	0.09					0.27	0.32	0.48
LS_UM	0.67	4.14	0.81	2.34	0.37	1.04	1.69	1.81	0.12	1.26
LS_UF	0.13	0.44	1.54	0.25			0.44	3.12	0.22	0.2
HS_RM	1.34		0.64	2.67	3.67	3.44	0.55	0.53	25	2.7
HS_RF	0.47		0.22				0.17		6.89	2.29
HS_UM	0.61	0.15	1.52	3.27	4.77	1.48	5.48	2.93	7.7	14.2
HS_UF	0.01		0.33	0.11	6.54	0.05	1.72	1.54	9.4	4.18
K	57.9	59.6	9.98	0.25	72.8	52.4	54.3	53.3	11.6	33
Total	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*

Source: Own Computations: 2002 Uganda SAM. LS: Low skilled, HS: High skilled; UM/F: Urban male/female, RM/F: Rural male/female, K: CapitaL. Activities (A) and Commodities (C): AGRI: Agriculture; MIN: Mining & Quarrying; PROC: Food Processing; MAN: Other Manufacturing; CONS: Construction; ELEC: Electricity and Water; TRS: Trade Service; TRAN: Transport; HEAL: Health and Education; OTH: Other Service (s): Activity (A) Column, and Commodity (C) Rows.

4.5 Trade Shares

Trade shares shed light on the structure and composition of imports and exports. Using data from the SAM, it can be shown (Table 4.5.1) that Uganda like many developing countries depend on exports of primary products such as agriculture (19 percent), processed food products (30 percent), and Services (24percent). Exports of manufactured goods (11 percent) and trade services (8 percent). These export earnings are used to pay for imported goods. Most of Uganda's imports are manufactured goods (68 percent), processed food produts (7.4 percent), agricultural imports (3.2 percent), transport services (13 percent) and other services (8 percent).

Table 4.5.1 Trade Shares (Imports and Exports as % of Total)

	Exports	Imports	Share of Exports	Share of Imports
Agriculture	293,230	95,049	19.4	3.2
Mining	10,286	27,469	0.7	0.9
Food Processing	447,599	218,275	29.6	7.4
Manufacturing	159,465	1,995,907	10.5	67.7
Electricity & Water	27,144		1.8	
Trade Services	118,719		7.8	
Transport	88,428	388,694	5.8	13.2
Other Services	369,419	224,686	24.4	7.6
Total	*1,514,289*	*2,950,081*	*100*	*100*

Source: Own computations; 2002 Uganda SAM. Coantruction and Health and Education commodities were neither exported or imported are therefore omitted.

To further understand the relative importance of trade in Uganda, we compute the export intensity (EI) and import penetration ratios (IPR). Export intensity is the share of exports in the value of gross output. The IPR is the share of imports in the value of total demand. Thus

$$\textit{Export Intensity (EI)} = \frac{\text{Exports}}{\text{Gross Output}} \qquad (4.1.a)$$

$$\textit{Import Penetration Ratio (IPR)} = \frac{\text{Imports}}{\text{Total Demand}} \qquad (4.1.b)$$

The IPRs calculated from the 2002 SAM (Table 4.5.2) suggest that Uganda's manufacturing sector is associated with the highest import competition because 58 percent of total demand in Manufacturing is supplied by foreigners. On the other hand, the share of imported agriculture goods in total agriculture demand was 2.7 percent. Therefore, Uganda's economy is self sufficent in agriculture goods but manufactured goods. The Calculated export intensities show that Food processing, Mining, Manufacturing and Agriculture are export intensive sectors, with 22.5 percent, 22.8 percent, 13.9 percent and 8 percent of their output being exported respectively.

Table 4.5.2 Trade Intensities

	Exports	Imports	Gross output	Total Demand	EI (%)	IPR (%)
Agriculture	293,230	95,049	3,579,120	3,456,701	8.2	2.7
Mining	10,286	27,469	45,752	82,809	22.5	0.8
Food Process	447,599	218,275	1,962,431	2,713,021	22.8	6.3
Manufacturing	159,465	1,995,907	1,147,192	4,022,085	13.9	57.7
Utilities	27,144	-	442,219	507,371	6.1	0.0
Construction	-	-	1,965,162	2,055,199	0.0	0.0
Trade Service	118,719	-	1,814,596	1,984,889	6.5	0.0
Transport	88,428	388,694	518,966	1,063,782	17.0	11.2
Health	-	-	1,606,666	1,902,055	0.0	0.0
Other Services	369,419	224,686	4,957,810	4,721,832	7.5	6.5

Source: Own computaions, 2002 Uganda SAM. EI: Export Intensity; IPR: Import Penetration Ratio. All other goods are in million Uganda shillings.

Total Demand Shares

Total demand shares take into account the various sources of commodity demand, including intermediate, private and public consumption, investment and exports. Demand shares by commodity (Table 4.5.3) show that agricultural goods (20 percent) and Food Processing (18 percent), and Other Service goods (17 percent) are the largest components of private consumption spending. Processed food products contributed about 30 percent of export demand, followed by Other Services (24 percent), agriculture (19 percent, and manuafactureed goods (10.5 percent). Government spending in concetrated on the output of the government services sector and largely dominated by education and health (45.3 percent), and Other Services (defense, housing, and other social services) contributed 54.6 percent. Finally, investment demand is mainly accounted for by construction (70 percent) and manufacturing (20 percent), Food Processing (5 percent), and Trade Services (3 percent). Output from the Manufacturing (28 percent) , Agriculture (16.9 percent), Trade Service (8.6) and Services (23 percent) are the main components of intermediate demand.

Table 4.5.3 Demand Shares (%) by Commodity

	Intermediate Demand	Private Consumption	Gov't Consumption	Investment	Exports
Agriculture	16.9	20.1	0.0	1.9	19.4
Mining	0.6	0.3	0.0	0.0	0.7
Food Process.	6.6	18.1	0.0	5.1	29.6
Manufac'ng	28.2	13.3	0.0	19.8	10.5
Utilities	2.2	3.5	0.0	0.0	1.8
Construction	2.8	1.6	0.0	70.0	0.0
Trade Service	8.6	12.6	0.0	2.8	7.8
Transport	6.7	4.9	0.1	0.4	5.8
Health& Educ	4.3	8.3	45.3	0.0	0.0
Other Servc's	23.2	17.3	54.6	0.0	24.4
Total	*100*	*100*	*100*	*100*	*100*

Source: Own Computations: 2002 Uganda SAM

Table 4.5.4 Demand Shares (%) by Source

	Intermediate Demand	Private Cons	Gov't Cons	Investment	Exports	Total
AGRIC	37.9	52.3	0	1.3	8.5	100
MIN	59.2	28.2	0	0.2	12.4	100
MAN	19	59.9	0	4.6	16.5	100
PROC	54.4	29.7	0	11.9	4	100
ELEC	33.3	61.4	0	0	5.3	100
CONS	10.6	7	0	82.4	0	100
TRS	33.5	57.1	0	3.4	6	100
TRAN	48.8	41.8	0.1	0.9	8.3	100
HEAL	17.5	39.4	43.1	0	0	100
OTH	38.2	33	20.9	0	7.8	100

Source: AGRI: Agriculture; MIN: Mining & Quarrying; PROC: Food Processing; MAN: Other Manufacturing; CONS: Construction; ELEC: Electricity and Water; TRS: Trade Service; TRAN: Transport; HEAL: Health and Education; OTH: Other Service (s):

Demand shares by source (Table 4.5.4) suggest that agriculture (52 percent), processed foods (60 percent), Utilities (61 percent), Trade Service (57 percent) and Transport (41.3 percent) are the main components of private consumption spending. Construction (82 percent) is the largest component of investment demand followed by Manufacturing (11.9 percent). Health and Education are the largest components of government consumption spending.

Household Expenditure and Demand Shares

The 2002 Uganda SAM, households are disaggregated by residence (i.e. rural and urban), and by region (i.e. central, eastern, northern, and western). This type of disaggregation enables us to consider differences in how these different household groups earn and spend their incomes and to study the distributional effects of various policies. Household demand shares (Table 4.5.5)

Table 4.5.5 Household Expenditure Shares (%)

Commodity	Rural households	Urban households
Agriculture	24.2	6.5
Mining	0.3	0.1
Food Processing	17.8	12.6
Manufacturing	12.3	10.6
Utilities	3.6	2.1
Construction	0.9	2.3
Trade Service	13.3	7.3
Transport	4.6	4.0
Health & Education	7.1	7.8
Other Services	12.9	19.3
Government	1.0	2.5
Rest of World	0.0	15.2
Savings/Investment	2.1	9.7
Total	*100*	*100*

Source: Own Compuations, 2002 Uganda SAM.

Table 4.5.5 shows that rural households spend most of their income on agricultural (24 percent), Processed Foods (17.8 percent), Trade Services (13.3 percent) and Other Services (12.9 percent). Urban households spend most of their income on other services (19 percent), processed food products (12.6 percent), manufactured goods (10.6 percent) and Trade Services (7.8 percent). Rural households save less of their income (2.1 percent) compared to urban households (9.7 percent). Urban households pay more in taxes (2.5 percent) compared to rural households (1 percent).

Household Income Shares

The discussion of factorial distributions of incomes is important because policy shocks cause changes in relative prices of commodities, which in turn impact on factor use and factor prices, subsequently affecting household welfare. In our SAM, factor income refers to payments received by households due to their ownership of labour, capital, and land. Total primary factor income is divided into mixed income (from employment of capital and labour), and net operating surplus (capital income) accruing to firms/enterprises. Mixed income was separated into two components i.e. mixed income from agricultural and non-agricultural activities. Mixed income from agricultural activities was allocated to household classes based on their shares of agricultural land holdings as weighting factors. Mixed income from non-agricultural activities was allocated to household classes using their shares of enterprise assets as weighting factors. In the complete SAM, the sum of mixed income and operating surplus equals the total primary capital factor income distributed.

In our earlier calculations, we saw that production in Uganda is labour and capital intensive[19]. Not surprisingly then, both rural and urban households earn most of their income from labour (32 percent) and capital (34 percent) on average (Table 4.5.6). Table 4.5.7 shows that rural households earn most of their incomes from capital (37 percent), and labour (24.7 percent). Urban households equally earn all their income from capital (42 percent) and labour (34 percent). Finally, rural households are the largest recipients of remittances in 2002. Urban households are the largest recipients of capital income and firm transfers.

[19] This is attributed to the allocation of mixed income with the largest share going to land owners and agriculture

Table 4.5.6 Household Income Shares (%) by Source

Household	Labour	Capital	Firm TRs	Gov't	Intra-hhd TRs	Remittances	Total
Central-r-hhd	21.5	35	12.3	0.53	25.2	6.1	100
Central-urb-hhd	32.9	46.3	16.3	0.83	0	3.6	100
Eastern-r-hhd	18.6	39.9	13.5	0.73	17.5	9.8	100
Eastern-urb-hhd	34.2	23.9	14	0.72	14.4	12.8	100
Northern-r-hhd	37.5	19.6	12.9	0.61	21	8.4	100
Northern-urb-hhd	47.4	13.2	14.2	0.38	12.4	12.5	100
Western-r-hhd	28.5	46.2	15.2	0.33	5.8	3.9	100
Western-urb-hhd	35.8	46	16.1	0.23	0	1.8	100
Average	*32*	*34*	*14*	*1*	*12*	*7*	*100*

Source: Computed by Author: 2002 Uganda SAM. hhd: household, rural r) or urban (urb). TRs: Transfers.

Table 4.5.7 All Households Income Shares (%) by Source

Source of income	All Rural Households	All Urban Households
Labour	24.7	34
Capital	37.4	42
Government	0.5	1
Remittances	6.7	5
Inter-household transfers	17.2	2
Firm Transfers	13.5	16
Total	*100*	*100*

Source: Own computations: 2002 Uganda SAM.

4.6 Labour Shares in Employment

Table 4.6.1 shows that the share of employed females was higher than that of males due to the large share of unpaid domestic female workers. Table 4.6.2 shows that rural areas accounted for the largest share in employment (84 percent) and agriculture employed more workers than other sectors.

Table 4.6.1 Factor Employment by Gender, Shares (%), 2002

	Share of females	Share of males	All workers
Self-employed in Agriculture	20.4	20.9	41.3
Self-employed in other sector	6.7	10.2	16.9
Government employee	0.9	2.1	3
Private employee	2.6	7.5	10.1
Unpaid farm. or domestic worker	23.5	5.2	28.7
All economically active	*54.2*	*45.8*	*100*

Source: Uganda Bureau of Statistics (UBOS) and Uganda National Household Survey (2002/2003).

Table 4.6.2 Employment by Location, Shares (%), 2002

Type of employment	Rural share	Urban share	Total share
Self-employed in agriculture	38.5	2.8	41.3
Self-employed in other sector	11.3	5.6	16.9
Government employee	2.2	0.8	3
Private employee	6.1	4	10.1
Unpaid fam. or domestic worker	26.1	2.6	28.7
All economically active labour force	*84.1*	*15.9*	*100*

Source: Uganda Bureau of Statistics (UBOS) and Uganda National Household Survey (2002/2003).

4.7 Conclusion

The information in the Ugandan SAM reveals a great deal about a country's economic structure. Our calculations show a number of key characteristics of Uganda's economy. For example, we now know that Uganda is an agriculture-based and labour-intensive economy that relies on agricultural and processed food product exports to pay for imported goods. However, primary exports are insufficient to pay for all exports, and the country runs a large current account deficit as a result. However, though investment is a large part of GDP, private consumption is the most important. Here we found that rural households spend a large share of income on agricultural and processed food products goods and derive more of their incomes from labour than do urban households. These structural characteristics of the Ugandan economy are important for explaining economic linkages and multiplier effects.

Chapter Five

A Social Accounting Matrix Multiplier Analysis for Uganda

5.1 Introduction and Motivation

Thorbecke and Jung (2002) illustrated that a good balanced Social Accounting Matrix (SAM) can be used as a tool to estimate the effects of exogenous changes and injections (i.e. changes in demand for sectoral outputs) on the socioeconomic system. Specifically, the authors developed a social accounting method to analyse the impact of production activities on poverty alleviation in Indonesia in the 1980s. Their findings suggest that agricultural and service sectors contribute more to poverty reduction that industrial sectors do. A similar methodology is used to study sectoral growth and poverty alleviation in South Africa (Khan, 1999). He finds that higher contributions to growth and poverty alleviation are derived from growth in agriculture, services, and some manufacturing sectors.

If a certain number of assumptions are met (i.e. the existence of excess capacity, and unemployed or underemployed factors), the SAM framework can be used to estimate the impact of exogenous changes and policies (i.e. such as an increase in the demand for certain activities and exports, or in government expenditure) on the socioeconomic system. To perform this function, the SAM is transformed into a model which generates round by round multiplier effects that incorporate all types of linkages in an economy (Thurlow *et al.*, 2009). The multipliers are contained in the inverse matrix, M_a.

As Roland-Holst and Sancho (1995) report, SAMs have been used to study (i) growth strategies in developing economies (Pyatt and Round –1985, Robinson - 1988), (ii) income distribution and redistribution (Pyatt and Roe –1977, Adelman and Robinson – 1978, Roland-Holst and Sancho –1992), (iii) fiscal policies (Whalley and Hillaire –1987) and decomposition of activity multipliers that shed light on the circular flow of income (Stone –1981, Pyatt and Round –1979, Defourny and Thorbecke –1984, Robinson and Roland-Holst –1988). In addition, SAM multiplier models have been widely used to study a wide range of policy issues including trade policies and macroeconomic shocks, and farm and non-farm linkages (Pyatt and Round, 1985; Haggblade and Hazel, 1989; Haggblade *et al*., 1991; Bautista, 2001; Diao *et al*., 2007; and Okalang, 2008). In addition, SAM based multiplier models can be used to identify key sectors of the economy through the analysis of the impact of demand side shocks on the entire socioeconomic system.

Unlike traditional input-output models which measure the effects of production linkages only (Type I closed input-output multipliers), SAM based models are an extension of the classic Leontief input-output model and measure the effects of both production and consumption linkages (Type II input-output multipliers). Consumption linkages are included by making domestic institutions (i.e. households and the government) "endogenous". SAM multipliers capture direct and indirect effects in the first and all subsequent rounds of the circular flow of income.

Consumption linkages are generated when an increase in production creates additional incomes for factors and households, which in turn increases demand for goods and services (Thurlow *et al*., 2009). The increase in demand for goods and services leads to increased production, completing the circular flow of incomes in the multiplier process (Figure 5.1.3). The size of consumption linkages depends on a number of factors which include: the share of factor income distributed to households; the composition of the consumption basket; and the share of domestically supplied goods in consumer demand. Available evidence from developing countries indicate that consumption linkages are much larger than production linkages, accounting for over 75-90 percent of total multiplier effects in Africa and 50-60 percent in Asia (Haggblade, Hammer and Hazell, 1991). Therefore, SAM multipliers are larger than input-output multipliers because they combine the production linkages and consumption linkages (e.g. output and institutional income multipliers.

In the next section, we develop the SAM multiplier model that would be used to study how exogenous changes in demand affect household factor endowments and income distribution.

5.2 The Unconstrained SAM Multiplier Model

Unconstrained SAM multiplier models are the simplest kinds of multiplier models because they make a number of limiting assumptions. They assume that prices are fixed and that any changes in demand will lead to changes in physical output rather than prices. This in turn requires an additional assumption that the economy's factor resources are unlimited or unconstrained, so that any increase in demand can be matched by an increase in supply. In addition, input coefficients of producers and consumption patterns of households are unaffected by exogenous changes, that is there is a linear relationship between all the functions representing the SAM columns and that is there is no behavioural change. This implies that activities in the SAM multiplier model assume Leontief production functions, and there is no substitution between imports and domestic production in the commodity columns (Arndt, Jensen, and Tarp 1998). Finally, the multiplier model assumes that all structural relationships between sectors and households in the economy are unaffected by exogenous changes in demand. In other words, the input coefficients of producers and the consumption patterns of households remain unchanged (that is, linkage effects are linear and there is no behavioural change).

5.2.1 The SAM as a Model

The easiest manner to transform a SAM in some kind of an economic model is to assume that all the relations are of linear type and that prices are fixed (at least in the short run). In that case the SAM can be used directly to simulate the effects of shocks on some exogenous variables or accounts. This type of exercise is known as SAM multiplier analysis and can be seen as an extension of input-output models. The first step in building the SAM multiplier model is to partition the SAM into exogenous and endogenous accounts (Thorbecke and Defourney, 1984), and then deriving the SAM multiplier model. Endogenous accounts being those for which changes in expenditure levels directly follow any changes in incomes. Exogenous accounts are those for which it is assumed that the expenditures are independent of incomes (Sadoulet and de Janvry, 2003).

Matrix algebra is used to derive the unconstrained multiplier formula. We will use a two-sector SAM to illustrate the underlying equations, although the final multiplier formula can be applied to SAMs with any number of sectors. Numbers in the SAM are replaced with letters or symbols so that we can refer to these in our equations. For example, X_1 refers to the value of gross output from activity 1, and Y refers to total household income (Table 5.2.1).

Table 5.2.1 Deriving the SAM Multiplier Model

	Activities		Commodities		Factors	Households	Exogenous demand	Total
	A_1	A_2	C_1	C_2	F	H	E	
A_1			X_1					X_1
A_2				X_2				X_2
C_1	Z_{11}	Z_{12}				C_1	E_1	Z_1
C_2	Z_{21}	Z_{22}				C_2	E_2	Z_2
F	V_1	V_2						V
H					$V_1 + V_2$			Y
E			L_1	L_2		S		E
Total	X_2	X_2	Z_1	Z_2	V	Y	E	

Source: Clemens Breisinger, Marcelle Thomas, and James Thurlow (2009). X is gross output of each activity (i.e., X_1 and X_2); Z is total demand for each commodity (i.e., Z_1 and Z_2); V is total factor income (equal to household income); Y is total household income (equal to total factor income); E is exogenous components of demand (government, investment, and exports).

The next step is to divide each column in Table 5.2.1 by its column total to derive coefficients of the matrix called "*M*-matrix." This is shown in Table 5.2.2. The *M* matrix excludes the exogenous components of demand.

Table 5.2.2 The Matrix of Coefficients, *M*

	Activities		Commodities		Factors	Households	Exogenous demand	Total
	A_1	A_2	C_1	C_2	F	H	E	
A_1			$b_1=X_1/Z_1$					X_1
A_2				$b_2=X_2/Z_2$				X_2
C_1	$a_{11}=Z_{11}/X_1$	$A_{12}=Z_{12}/X_2$				$c_1= C_1/Y$	E_1	Z_1
C_2	$A_{21}=Z_{21}/X_1$	$A_{22}=Z_{22}/X_2$				$c_2=C_2/Y$	E_2	Z_2
F	$v_1=V_1/X_1$	$v_2=V_2/X_2$						V
H					1			Y
E			$I_1=L_1/Z_1$	$I_2= L_2/Z_2$		s=S/Y		E
Total	1	1	1	1	1	1	E	

Source: Clemens Breisinger, Marcelle Thomas, and James Thurlow (2009).
a is technical coefficients (i.e., input or intermediate shares in production),
b is the share of domestic output in total demand,
v is the share of value-added or factor income in gross output,
I is the share of the value of total demand from imports or commodity taxes,
c is household consumption expenditure shares and,
s is the household savings rate (i.e., savings as a share of total household income).

Using the symbols in the SAM, total demand Z in each sector is the sum of intermediate input demand, household consumption demand, and other exogenous sources of demand E, such as public consumption and investment. This is shown in equations 5.2.

$$Z_1 = a_{11}X_1 + a_{12}X_2 + c_1Y + E_1 \; ; \qquad Z_2 = a_{21}X_1 + a_{22}X_2 + c_2Y + E_2 \quad (5.2)$$

From the SAM, gross output X is only part of total demand Z, as shown in equations 5.3

$$\mathrm{X_1 = b_1Z_1;\ X_2 = b_2Z_2} \quad (5.3)$$

We also know that total household income depends on the share of factors' earnings in each sector, as shown in Equation 5.4.

$$Y = v_1X_1 + v_2X_2 = v_1b_1Z_1 + v_2b_2Z_2 \quad (5.4)$$

Replacing X and Y in Equations 5.2 using Equations 5.3 and 5.4, we get equations 5.5

$$Z_1 = a_{11}b_1Z_1 + a_{12}b_2Z_2 + c_1(v_1b_1Z_1 + v_2b_2Z_2) + E_1$$

$$Z_2 = a_{12}b_1Z_1 + a_{22}b_2Z_2 + c_2(v_1b_1Z_1 + v_2b_2Z_2) + E_2 \quad (5.5)$$

Moving all terms except for the exogenous demand E, to the left we have

$$Z_1 - a_{11}b_1Z_1 - c_1v_1b_1Z_1 - a_{12}b_2Z_2 - c_1v_2b_2Z_2 = E_1$$

$$-a_{12}b_1Z_1 - c_2v_1b_1Z_1 + Z_2 - a_{22}b_2Z_2 - c_2v_2b_2Z_2 = E_2 \quad (5.6)$$

Grouping Z terms together, we have

$$(1 - a_{11}b_1 - c_1v_1b_1)Z_1 + (-a_{12}b_2 - c_1v_2b_2)Z_2 = E_1$$

$$(-a_{21}b_1 - c_2v_1b_1)Z_1 + (1 - a_{22}b_2 - c_2v_2b_2)Z_2 = E_2 \qquad (5.7)$$

Applying matrix algebra on equations 5.7 and collecting like terms we have

$$\begin{pmatrix} 1 - a_{11}b_1 - c_1v_1b_1 & -a_{12}b_2 - c_1v_2b_2 \\ -a_{21}b_1 - c_2v_1b_1 & 1 - a_{22}b_2 - c_2v_2b_2 \end{pmatrix}\begin{pmatrix} Z_1 \\ Z_2 \end{pmatrix} = \begin{pmatrix} E_1 \\ E_2 \end{pmatrix} \qquad (5.8)$$

The first term in Equation 5.8 is the identity matrix, I minus the coefficient matrix, *M*. Renaming vectors Z_1 and Z_2 as Z and vectors E_1 and E_2 as *E*, equation 5.8 can be expressed as

$$(1 - M)Z = E \qquad (5.9)$$

Rearranging equation 5.9, we arrive at the SAM multiplier formula in equation (5.10)

$$Z = (1 - M)^{-1}E \qquad (5.10)$$

$$Z = M_aE \qquad (5.11)$$

M_a is the inverse matrix or the unconstrained accounting multiplier matrix (Pyatt and Round, 1979; Thorbecke and Jung, 1994) because it explains results obtained in a SAM and not the process by which they are generated. Equation 5.11 tells us that, when exogenous demand E increases, then after taking all rounds of direct and indirect linkage effects into account, we get the final increase in in total demand equal to Z (that is, some multiple of the initial or direct shock). The multipliers contained in matrix M_a can be classified as gross output, demand, value added/GDP, and institutional income multipliers.

5.3 Interpreting the Unconstrained Accounting Multiplier Matrix, M_a

Each cell m_{ij} of the matrix M_a quantifies the change in account *i*'s income as a result of an exogenous change in account *j*'s income. Alternatively, each cell in the multiplier matrix indicates the total (direct and indirect) change in income in the endogenous row account as a result of an exogenous injection of a unit income in the column account. Each entry captures the Leontief (input-output) production linkages or direct effects and the consumption expenditure linkages (indirect effects) induced by changes in production activities through their effect on the incomes of households (Robinson *et al*., 1999). If there is an increase in final demand for a particular commodity, we can assume that there will be an increase in the output of that commodity, as producers react to meet the increased demand; this is the direct effect. When producers increase their output, this will induce increased on their suppliers and this continues down the entire supply chain; this is the indirect effect. As a result of the direct and indirect effects the level of household income throughout the economy will increase as a result of increased employment. A proportion of this increased income will be re-spent on final goods and services: this is the induced effect. The ability to quantify these multiplier effects is important as it allows economic impact analyses to be carried out the Ugandan economy.

The multipliers of the matrix M_a are further subdivided into four sub-groups namely: Output, demand, factorial income (value added GDP), and institutional income multipliers. This study discusses only the commodity/demand multipliers extracted from the unconstrained multiplier matrix, M_a. The overall multiplier matrix is available upon request. If the policy maker was interested in analysing the impact of a given change in final demand for agriculture on the socioeconomic system, he or she could read the relevant multipliers down the corresponding column of the commodities block of the accounting multiplier matrix. In addition, if the policy maker was interested in analysing the impact of a given change in household incomes resulting from an exogenous change in factor demands, he/she could read the column entries of the factor block corresponding to the row entries of household's accounts.

5.3.1 Gross Output Multipliers

The output multiplier for an industry is expressed as the ratio of direct and indirect (and induced if Type II multipliers are used) output changes to the direct output change due to a unit increase in final demand. If we multiply a change in final demand (direct impact) for an individual industry's output by that industry's Type I output multiplier, we will generate an estimate of direct and indirect impacts upon output throughout the Ugandan economy. In this dissertation, gross output multipliers are extracted from the commodity column and activity rows of the accounting multiplier matrix, M_a. These multipliers combine all direct and indirect (consumption and production) effects across multiple rounds and report the final increase in gross output of all production activities. They therefore represent Leontief Type II multipliers. These multipliers are presented in Table 5.3.1. If the final demand in agriculture increases by 1 million shillings, the output of Construction would increase by 0.05 million shillings. Similarly, an increase in final demand of Manufacturing by 1 million shillings would increase Agriculture’s output by 0.13 million shillings. If the final demand for agriculture increases by 1 million shillings, agriculture own output increases by an additional 0.63 million shillings.

Table 5.3.1 Sectoral Gross Output Multipliers

	AGRI	MIN	PROC	MAN	ELEC	CONS	TRS	TRAN	HEAL	OTH
AGRI	1.634	0.292	0.859	0.134	0.462	0.423	0.485	0.280	0.500	0.456
MIN	0.004	0.589	0.004	0.003	0.004	0.014	0.004	0.002	0.004	0.004
PROC	0.288	0.151	1.046	0.075	0.242	0.224	0.264	0.150	0.260	0.243
MAN	0.180	0.152	0.183	0.447	0.164	0.248	0.183	0.129	0.202	0.175
ELEC	0.077	0.051	0.066	0.019	1.036	0.062	0.083	0.048	0.086	0.079
CONS	0.046	0.028	0.041	0.013	0.042	1.040	0.053	0.032	0.057	0.071
TRS	0.293	0.164	0.287	0.083	0.244	0.247	1.180	0.178	0.288	0.258
TRAN	0.082	0.042	0.074	0.021	0.066	0.076	0.111	0.549	0.079	0.081
HEAL	0.161	0.086	0.126	0.043	0.137	0.127	0.150	0.088	1.029	0.171
OTH	0.537	0.343	0.498	0.149	0.495	0.470	0.756	0.464	0.788	1.615
Total Multiplier	*3.301*	*1.898*	*3.184*	*0.987*	*2.890*	*2.932*	*3.269*	*1.919*	*3.294*	*3.153*

Source: Own Computations. SAM Multiplier Model Results. AGRI: Agriculture; MIN: Mining & Quarrying; PROC: Food Processing; MAN: Other Manufacturing; CONS: Construction; ELEC: Electricity and Water; TRS: Trade Service; TRAN: Transport; HEAL: Health and Education; OTH: Other Service (s):

A direct increase in exogenous agricultural demand by 1 million shillings leads to a total increase in gross output by 3.3 million shillings once all linkage effects and if all round by round effects are accounted for. Compared to other sectors, Agriculture, Trade Services, Food Processing, and Other Services experience higher total output multiplier effects given an exogenous increase in demand and when all the linkage and round by round effects are accounted for. Compared to other sectors, the Mining and Manufacturing sectors experience the least increase in their total gross output multiplier given an exogenous increase in demand in other sectors by 1 million shillings. This is because Mining and Manufacturing sectors have weak forward and backward linkages relative to other sectors (Figure 5.5.2).

5.3.2 Demand Multipliers

Demand multipliers (Table 5.3.2) combine all direct and indirect effects across multiple rounds and report the final increase in demand for each commodity following an exogenous change in demand. If the final demand in agriculture increases by 1million shillings, the demand for agriculture's own output increases by an additional 0.7 million shillings. A similar injection would increase the demand for Processed Food and Trade Services by 0.38 and 0.3 million shillings respectively. A direct increase in exogenous agricultural demand by 1 million shillings leads to a total increase in demand by 3.3 million shillings once all linkage effects and if all round by round effects are accounted for. An exogenous demand of 1 million shillings increases total demand of Health Services, Food Processing, and Trade Services by 3.8 million shillings respectively when all multiplier effects are accounted for. The total demand for Mining and Manufacturing experience the least increase given exogenous demand of 1 million shillings. This is because these sectors have weak forward and backward linkages (Figure 5.5.2).

Table 5.3.2 Sectoral Demand Multipliers

	AGRI	MIN	PROC	MAN	ELEC	CONS	TRS	TRAN	HEAL	OTH
AGRIC	1.679	0.283	0.724	0.131	0.447	0.410	0.467	0.270	0.485	0.440
MIN	0.007	1.005	0.006	0.005	0.006	0.023	0.007	0.004	0.007	0.007
PROC	0.378	0.200	1.430	0.080	0.322	0.290	0.351	0.199	0.344	0.322
MAN	0.479	0.329	0.446	1.254	0.436	0.656	0.495	0.350	0.548	0.470
ELEC	0.080	0.053	0.069	0.020	1.084	0.065	0.086	0.050	0.089	0.081
CONS	0.046	0.028	0.041	0.012	0.042	1.063	0.053	0.032	0.058	0.072
TRS	0.313	0.176	0.309	0.084	0.261	0.264	1.285	0.186	0.308	0.271
TRAN	0.160	0.082	0.145	0.041	0.128	0.150	0.213	1.089	0.155	0.157
HEAL	0.185	0.097	0.142	0.036	0.156	0.142	0.169	0.098	1.234	0.183
OTH	0.501	0.329	0.465	0.137	0.469	0.435	0.647	0.340	0.604	1.674
Total Demand Multiplier	*3.828*	*2.580*	*3.777*	*1.801*	*3.352*	*3.497*	*3.774*	*2.618*	*3.833*	*3.677*

Source: Own computations. SAM Multiplier Model Results. AGRI: Agriculture; MIN: Mining & Quarrying; PROC: Food Processing; MAN: Other Manufacturing; CONS: Construction; ELEC: Electricity and Water; TRS: Trade Service; TRAN: Transport; HEAL: Health and Education; OTH: Other Service (s):

5.3.3 Factor Income/ GDP Multipliers

Generally, income multipliers measure the change in income (compensation of employees) which occurs throughout the economy as a result of a change in final demand. They show the ratio of direct plus indirect (plus induced if Type II multipliers are used) income changes to the direct income change. Factor incomes or GDP multiplier measures the total change in value added or factor incomes caused by direct and indirect effects following an exogenous change in demand. The factor income multipliers presented in Table 5.3.3 shows that a direct increase in agriculture's exogenous demand by 1 million shillings increases total factor income by an addition 1.12 million shillings when all indirect effects and round by round linkage effects are accounted for. An exogenous increase in agriculture demand is associated with higher factor incomes because agriculture is labour and capital intensive (i.e. agriculture is Uganda's top employer). Generally, if all multiplier effects are accounted for, aggregate factor income multiplier would be higher if the increase in exogenous demand were to be in Agriculture; Education and Health; Electricity and Water; Trade Services; and Other Services but low in Manufacturing and Construction. Manufacturing has the lowest aggregate factor income multiplier owing to its low share of mixed income in total capital income and value added. Mixed income was allocated to households based on land ownership, with the highest share going to Agriculture. In addition our key sector analysis (Table 5.7.1 and Figure 5.7.2) shows that Manufacturing is characterised by weak forward and backward linkages. Round by round linkages affect the size of multipliers.

Table 5.3.3 Factor Income/GDP Multipliers

	AGRI	MIN	PROC	MAN	ELEC	CONS	TRS	TRAN	HEAL	OTH
Low skilled-r-male	0.224	0.157	0.134	0.057	0.073	0.075	0.086	0.080	0.094	0.086
Low skilled-r-female	0.036	0.022	0.021	0.008	0.012	0.011	0.013	0.014	0.017	0.018
Low skilled-urb-male	0.032	0.061	0.035	0.035	0.024	0.032	0.041	0.039	0.026	0.037
Low skilled-urb-female	0.012	0.013	0.027	0.008	0.009	0.009	0.015	0.039	0.013	0.012
High skilled-r-male	0.091	0.067	0.081	0.063	0.099	0.095	0.077	0.070	0.333	0.106
High skilled-r-female	0.033	0.025	0.030	0.015	0.024	0.022	0.029	0.024	0.099	0.053
High skilled-urb-male	0.132	0.121	0.144	0.103	0.155	0.118	0.188	0.145	0.213	0.283
High skilled-urb-female	0.051	0.047	0.052	0.030	0.104	0.041	0.069	0.060	0.150	0.097
Capital	1.505	1.309	1.144	0.500	1.387	1.191	1.342	1.241	0.955	1.156
Agg .GDP Multiplier	*2.116*	*1.824*	*1.670*	*0.819*	*1.888*	*1.593*	*1.861*	*1.712*	*1.900*	*1.847*

Source: Own computations. SAM Multiplier Model Results. Labour is resident in rural (r) or urban areas (Urb). K: Capital. AGRI: Agriculture; MIN: Mining & Quarrying; PROC: Food Processing; MAN: Other Manufacturing; CONS: Construction; ELEC: Electricity and Water; TRS: Trade Service; TRAN: Transport; HEAL: Health and Education; OTH: Other Service (s):

5.3.4 Institutional Income Multipliers

Institutional income multipliers measure the total change in institutional incomes arising from an exogenous change in demand for a given sector's output. The calculated household income multipliers (Table 5.3.4) shows that a direct increase in agriculture's exogenous demand by 1 million shillings leads to a total increase in household incomes by 2.1 million shillings if all linkages and all round by round effects are taken into account. Similarly, a direct exogenous increase in demand of 1 million shillings for Trade Services, Social Services, and Utilities would increase total household incomes by 1.93, 1.94, and 1.9 million shillings respectively. Manufacturing, Mining and Construction sectors are characterised by weak forward and backward linkages and small income multipliers.

Table 5.3.4 Institutional Income Multipliers

	AGRI	MIN	PROC	MAN	ELEC	CONS	TRS	TRAN	HEAL	OTH
CR_H	0.428	0.227	0.307	0.07	0.363	0.325	0.371	0.213	0.384	0.340
CU_H	0.612	0.355	0.482	0.118	0.624	0.519	0.65	0.375	0.584	0.624
ER_H	0.300	0.159	0.214	0.048	0.254	0.227	0.259	0.149	0.256	0.230
EU_H	0.071	0.042	0.057	0.015	0.075	0.061	0.079	0.045	0.075	0.080
NR_H	0.144	0.074	0.103	0.025	0.116	0.106	0.118	0.068	0.160	0.117
NU_H	0.036	0.022	0.031	0.009	0.038	0.032	0.043	0.025	0.042	0.046
WR_H	0.362	0.187	0.254	0.056	0.29	0.265	0.296	0.17	0.319	0.269
WU_H	0.116	0.068	0.092	0.023	0.116	0.099	0.124	0.072	0.109	0.120
Total	*2.069*	*1.134*	*1.54*	*0.364*	*1.876*	*1.634*	*1.94*	*1.117*	*1.929*	*1.83*

Source: Own computations. SAM Multiplier Model Results. Households (H) are classified as being rural (R) or urban (U) residents and located in the Central (C), Eastern (E), Northern (N) or Western (W) regions.

Generally, the income multiplier results indicate that households in the central and western regions experiences higher income impacts than households in other regions following an exogenous demand by agriculture. The ownership of low skilled labour who are dominantly employed in agriculture and concentration of agriculture activities in these regions is partly responsible for increased household incomes after the shock.

5.4 SAM Multipliers and Sector Rankings

Rankings based on aggregate multipliers are presented in Tables 5.4.1 and 5.4.2. Agriculture is ranked highest with regard to gross output multipliers, factor income/value GDP multipliers and household income multipliers. Agriculture is ranked second with regard to demand multipliers. Our computed aggregate multipliers are consistent with the findings of previous studies which conclude that agriculture is Uganda's key sector. Most of these studies argue that policy interventions for growth and poverty alleviation should target the agricultural sector (Thurlow *et al*., 2008; and Dorosh *et al*., 2002).

Table 5.4.1 Aggregate Multipliers and Sectoral Rankings

1 million shillings increase in final demand for each sector	Gross output Multiplier	Rank	Demand Multiplier	Rank
Agriculture	3.301	1	3.828	2
Mining	1.898	9	2.580	9
Food Processing	3.184	4	3.777	3
Manufacturing	0.987	10	1.801	10
Utilities	2.890	7	3.352	7
Construction	2.932	6	3.497	6
Trade Service	3.269	3	3.774	4
Transport	1.919	8	2.618	8
Heal & Educ	3.294	2	3.833	1
Other Service	3.153	5	3.677	5

Source: Own calculations-SAM multiplier model.

Table 5.4.2 Aggregate Multipliers and Sectoral Rankings

1 million shillings increase in final demand in each sector	GDP Multiplier	Rank	Income Multiplier	Rank
Agriculture	2.012	1	2.568	1
Mining	1.095	8	1.407	8
Food Processing	1.485	7	1.898	7
Manufacturing	0.347	10	0.438	10
Utilities	1.805	4	2.339	3
Construction	1.581	6	2.045	6
Trade Service	1.860	2	2.403	2
Transport	1.070	9	1.381	9
Health & Education	1.844	3	2.264	4
Other Service	1.736	5	2.210	5

Source: Own Calculations-SAM Multiplier Model.

On the other hand, Manufacturing, Construction, Mining, and Transport sectors have low aggregate multiplier rankings for any given change in exogenous demand. These sectors have weak forward and backward linkages (Figure 5.7.2).

5.5 Multiplier Rankings of Sectors for Wage Generation

The multiplier rankings presented in Table 5.5.1 suggest that for rural labour (male and female); the multiplier for wage generation is highest in Agriculture, followed by Food Processing. For skilled rural male and female labour, Education and Health are the leading wage generating sectors followed by other private and government services.

Table 5.5.1 Sector Rankings for Rural Labour Groups Wage Generation

1unit increase in final demand for each sector	Low Skilled Male	Rank	Low Skilled Female	Rank	High Skilled Male	Rank	High Skilled Female	Rank
Agriculture	0.213	1	0.034	1	0.087	5	0.031	3
Mining	0.094	3	0.013	6	0.041	9	0.015	9
Food Process	0.125	2	0.020	2	0.071	7	0.026	5
Manufacturing	0.024	10	0.003	10	0.027	10	0.007	10
Utilities	0.070	8	0.012	7	0.095	3	0.023	6
Construction	0.075	6	0.011	8	0.094	4	0.022	7
Trade Service	0.086	5	0.014	5	0.079	6	0.031	3
Transport	0.050	9	0.009	9	0.047	8	0.018	8
Health &Educ	0.091	4	0.017	3	0.290	1	0.090	1
Other Service	0.081	8	0.017	3	0.101	2	0.050	2
Average	*0.091*		*0.015*		*0.093*		*0.031*	

Source: Own Calculations-SAM Multiplier Model.

With regard to urban based labour, our rankings in Table 5.5.2 show that a direct increase by 1 million in exogenous demand for Trade Service and Food Processing will have a greater impact on the incomes of low skilled male and female labour relative to a similar shock to other sectors. For urban high skilled male labour, other private and government services have higher multiplier impact on wage generation compared to other sectors. Health and Education services are ranked highest for high skilled female labour wage generation given a direct increase in exogenous demand by 1 million shilling for these services.

Table 5.5.2 Sector Rankings for Urban Labour Groups Wage Generation

1million shillings increase in final demand for each sector	Low Skilled Male	Rank	Low Skilled Female	Rank	High Skilled Male	Rank	High Skilled Female	Rank
Agriculture	0.030	5	0.012	4	0.126	5	0.048	5
Mining	0.037	2	0.008	9	0.074	9	0.029	9
Food Process	0.030	5	0.022	1	0.123	6	0.045	6
Manufacturing	0.013	10	0.003	10	0.043	10	0.013	10
Utilities	0.023	9	0.009	7	0.148	4	0.099	2
Construction	0.032	4	0.009	7	0.119	7	0.041	7
Trade Service	0.040	1	0.015	3	0.196	3	0.071	4
Transport	0.024	8	0.021	2	0.104	8	0.041	7
Health &Educ	0.027	7	0.012	4	0.218	2	0.138	1
Other Service	0.035	3	0.012	4	0.264	1	0.092	3
Average	0.029		0.012		0.142		0.062	

Source: Own computations-SAM Multiplier Model Results.

5.6 Ranking of Sectors for Household Incomes Generation

The sectoral rankings for household income generation are presented in Table 5.6.1 and Table 5.6.2 below. A direct increase in agriculture's exogenous demand of 1 million shillings has the highest income multiplier effect for rural households. This is followed by Trade Services, and Education and Health, Trade Services, Electricity and Water (Utilities), Construction and Food Processing. Agriculture is ranked first with regard to rural income generation. Mining, Manufacturing and Transport are the least household income generating sectors for a unit increase in exogenous demand by these sectors.

Table 5.6.1 Sector Rankings for Rural Households Income Generation

1 million shs. Increase in exog. demand in each sector	Central	Rank	East'n	Rank	Nort'n	Rank	West'n	Rank
Agriculture	0.428	1	0.300	1	0.144	2	0.362	1
Mining	0.227	8	0.159	8	0.074	8	0.187	8
Food Process.	0.307	7	0.214	7	0.103	7	0.254	7
Manufacturing	0.070	10	0.048	10	0.025	10	0.056	10
Utilities	0.363	4	0.254	4	0.116	5	0.29	4
Construction	0.325	6	0.227	6	0.106	6	0.265	6
Trade Service	0.371	3	0.259	2	0.118	3	0.296	3
Transport	0.213	9	0.149	9	0.068	9	0.17	9
Health & Educ	0.384	2	0.256	3	0.160	1	0.319	2
Other Service	0.340	5	0.234	5	0.117	4	0.269	5
Average	0.303		0.210		0.103		0.265	

Source: Own Computations-SAM Multiplier Model Results.

Urban households would benefit most if the exogenous increase in demand was in the services sector. A direct exogenous increase in demand of 1 million shillings in Trade Services would significantly increase the incomes of all households by 0.04 million shillings to 0.65 million shillings. Central and western based households are the top beneficiaries from an increase in exogenous demand in Trade Services. Northern and eastern based households benefit more from an exogenous increase in demand in Other Services (i.e. banking, tourism, hotel, and other public services etc.). Manufacturing, Transport, and Mining are the least household income generating sectors given an increase in exogenous demand in those sectors.

Table 5.6.2 Sector Rankings for Urban Households Income Generation

1 million increase in sector's exogenous demand	Central	Rank	East'n	Rank	North'n	Rank	West'n	Rank
AGRIC	0.612	4	0.071	5	0.036	5	0.116	3
MIN	0.355	9	0.042	9	0.022	9	0.068	9
PROC	0.482	7	0.057	7	0.031	7	0.092	7
MAN	0.118	10	0.015	10	0.009	10	0.023	10
ELEC	0.624	2	0.075	3	0.038	4	0.116	3
CONS	0.519	6	0.061	6	0.032	6	0.099	6
TRS	0.65	1	0.079	2	0.043	2	0.124	1
TRAN	0.375	8	0.045	8	0.025	8	0.072	8
HEAL	0.584	5	0.075	3	0.042	3	0.109	5
OTH	0.624	2	0.08	1	0.046	1	0.12	2
Average	0.494		0.06		0.032		0.094	

Source: Author's calculations. SAM Multiplier Model Results.

5.7 Linkage Analysis and Key Sectors for Uganda

Linkage analysis used to examine sectoral interdependency in production structures has a long history within the field of input-output analysis. Linkage analysis dates back to the pioneering work of Chenery and Watanabe (1958), Rasmussen (1956), and Hirschman (1958) who applied this technique to compare international production structures. Since then, linkage analysis has been expanded to include backward and forward linkages, and various methods have been proposed to measure inter-sectoral linkages and the identification of key sectors and economic policies (Hirschman, 1958). The methods used in linkage analysis may be summarised into two main categories. One is the traditional measurement based on the input-output coefficients (i.e. Chenery-Watanabe method, 1958; and the Rasmussen method; 1956), and the hypothetical extraction method (Strassert, 1968; and Cella, 1984). Chenery and Watanabe (1956) were the first to supply a quantitative evaluation of the backward and forward linkages in their analysis and comparison of international production structures. They suggest that backward linkages are measured by the column sums of the input coefficient matrix. According to this method, the calculated backward linkage of sector *j* is defined as

$$BL_j^c = \sum_{i=1}^{n} \frac{x_{ij}}{x_j} = \sum_{i=1}^{n} a_{ij} \tag{5.12}$$

BL_j^C denotes the backward linkage of sector j for the Chenery-Watanabe method, x_{ij} is the magnitude of sector *i*'s output used as production input by sector j, x_j is the output of sector *j*, and a_{ij} is the input coefficient of sector *j* to sector *i*. The corresponding forward linkage of sector *i* can expressed as follows:

$$FL_i^c = \sum_{j=1}^{n} \frac{x_{ij}}{x_j} = \sum_{i=1}^{n} b_{ij} \tag{5.13}$$

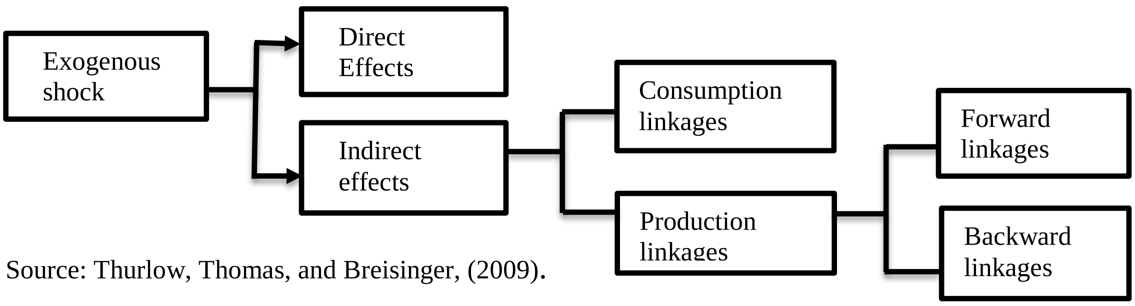
FL_i^C refers to the forward linkage of sector i; x_j is the output of sector j and b_{ij} is the output coefficient of sector i to sector j.

It should be noted that the Chenery-Watanabe method is based on direct input-output coefficients and measures only the first around effects on sectoral interrelationships. The resulting coefficients can also be referred to as direct backward and forward linkages. Though popular, this method has been criticised because it ignores indirect effects. To address this problem, the SAM multiplier matrix used in this dissertation is decomposed to account for direct and indirect effects of a shock to each sector *j* on the socioeconomic system or on incomes of other sectors *i*. On the other hand, the Chenery-Watanabe (1956) and Rasmussen (1958) linkage analyses are used to examine how the international structure of the economy behaves and changes. This behaviour and change of coefficients is critical in identifying key sectors in the internal structure of the economy. For this reason, we use this linkage analysis to determine the key sectors of Uganda's economy, a key research question of this dissertation. On the other hand, if our interest were to determine which sectors were responsible for the growth of overall output and GDP in the economy, we would have preferred the Dietzenbacher and van der Linden extraction methods (Dietzenbacher and van der Linden, 1997) over the Chenery and Watanabe (1956) and Rasmussen (1958) linkage analyses.

This dissertation uses the backward and forward production linkages generated by the SAM multiplier matrix, M_a to identify Uganda's key sectors. It is the production structure of the economy that shows the degree of interdependency between producing and consuming sectors of the economy (input-output sectoral linkages). Exogenous demand shocks generate both direct and indirect effects. Direct effects pertain to the sector that is directly affected by the shock (i.e. an exogenous increase in demand for Uganda's agriculture exports have a direct impact on agriculture's own domestic production. Similarly, the increase in demand might have indirect effects on other sectors with which agriculture has strong linkages. Indirect effects can be divided into production and consumption linkages. When all direct and indirect linkages are added, we arrive at the shock's total multiplier effect. The multiplier effect measures how much a direct effect is multiplied by indirect linkage effects. Production linkages can also be categorised as forward and backward linkages (Figure 5.7.1).

Production linkages are determined by a sector's production technologies which are contained in in the input-output section of the SAM. There are further divided into backward and forward linkages. Backward production linkages (*BL*) are the demand for inputs used by producers to supply additional goods and services. For example, when the production of the agriculture sector expands, it demands intermediate goods and services as fertilisers, machinery, and transport services. Increased demand for inputs stimulates production in other sectors as manufacturing to supply these intermediate inputs. Note that the magnitude of a sector's backward linkages depends on its intensive use of inputs in its production technology (Breisinger, *et al*., 2009). On the other hand, forward production linkages (*FL*) relate to increased supply of inputs to upstream industries. For example, when agricultural production expands, it can supply more goods to the food processing sector, which further stimulates the manufacturing sector. If a sector is intensive in the supply of inputs to upstream industries, it is said to have strong forward linkages.

Figure 5.7.1 Effects of an Exogenous Shock on the Multiplier



Source: Thurlow, Thomas, and Breisinger, (2009).

The column total of the accounting matrix M_a is equivalent to backward expenditure linkages (*BL*), and the row total of the matrix M_a gives the total forward income linkages (*FL*). The normalized linkages summarized in Table 5.7.1 shows the performance of each sector to the overall average of economic performance (i.e. the aggregate contribution of each sector to exogenous demand when all linkages are taken into account). Based on sectoral production linkages, we can determine the key sectors for Uganda (i.e. sectors for which both forward and backward linkages are greater than unity). Forward oriented ($BL<1$, $FL>1$) or backward oriented sectors ($FL<1$, $BL>1$) can be determined in a similar manner.

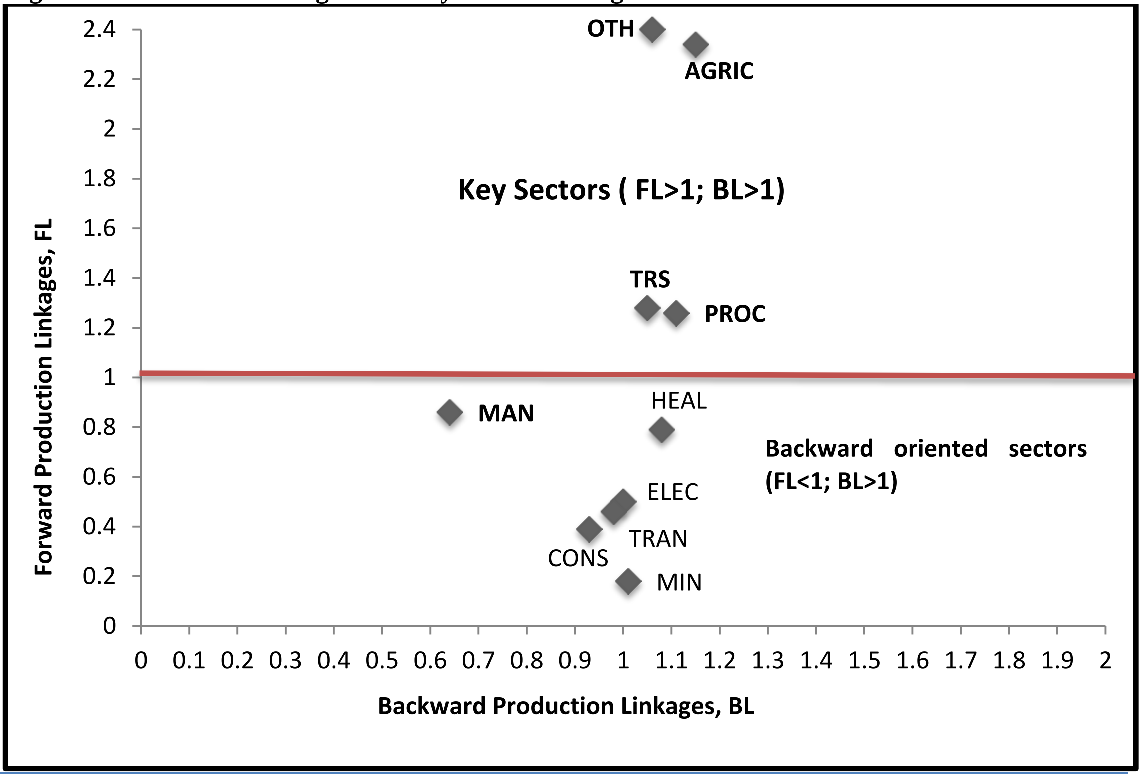
Table 5.7.1 Standardised Forward and Backward Linkages

Sector	Total BL	Total FL	Averaged BL	Averaged FL
Agriculture	11.3	22.9	1.15	2.34
Mining	9.86	1.77	1.01	0.18
Food Process	10.8	12.4	1.11	1.26
Manufacturing	6.31	8.39	0.64	0.86
Utilities	9.81	4.92	1	0.5
Construction	9.11	3.83	0.93	0.39
Trade Service	10.3	12.5	1.05	1.28
Transport	9.57	4.46	0.98	0.46
Education & Health	10.5	7.72	1.08	0.79
Other Service	10.4	23.4	1.06	2.4

Source: Own calculations. 2002 Uganda SAM. Each total linkage is divided by the average value of all the multipliers in the accounting matrix excluding those of the exogenous accounts to obtain the averaged backward and forward linkages.

The scatter diagram (Figure 5.7.2) of the forward and backward linkages above shows that Agriculture, Other Services, Trade Service, and Food Processing are key sectors for Uganda. Meanwhile, Manufacturing, Construction, and Transport sectors have weak linkages with the rest of the economy. Utilities (electricity and water), Health and Education, and Mining are backward oriented sectors.

Figure 5.7.2 Sectoral Linkages and Key Sectors for Uganda



Source: Own calculations. 2002 Uganda SAM. OTH: Other Services; AGRIC: agriculture; TRS: Trade Service; PROC: Food Processing; ELEC: Electricity and Water; HEAL: Health and Education; MIN: Mining TRAN: Transport; CONS: Construction; and MAN: Manufacturing.

5.8 SAM Multiplier Decomposition: A Mathematical Derivation

In this section, we decompose the accounting multiplier matrix, M_a into three additive components and analyse the effects of exogenous policy changes on the endogenous accounts of the SAM. Pyatt and Round (1979) decomposed the accounting multiplier matrix into three multiplicative components that capture the direct and indirect effects of a shock to the SAM, that is $M_a = M_3M_2M_1$. M_1, M_2, *and* M_3 capture transfer (within account) effects, cross effects (spill over), and circular (between accounts) effects of exogenous injections respectively.

Intuitively, M_1 captures the effects arising from direct transfers within the endogenous accounts (i.e. between production activities). It is referred to as the transfer multiplier. M_2 captures the cross effects of the multiplier process where by a shock to one part of the socioeconomic system affects other parts of the system (i.e. from production activities to factors, and to institutions). These effects are sometimes referred to as open loop effects. M_3 or closed loop effects ensure that the circular flow of income is completed among endogenous accounts (i.e. from production activities to factors, to institutions, to commodities and then back to activities in form of consumption, demand, income etc.). The multiplier decomposition used in this dissertation was applied to Lesotho to analyse growth and poverty alleviation prospects of selected exogenous changes and policies (Nganou, 2005). The decomposition is derived as follows:

Let $Y = M_1M_2M_3X$; where $M_a = M_1M_2M_3$ (5.14)

Let $M_1 = (I - A_0)^{-1}$; $M_2 = \left(\sum_{n-1}^{1} (A^*)^i \right) + I$; and $M_3 = \left(I - (A^*)^n \right)^{-1}$.

A_0 is a square matrix with diagonal elements (i.e. average propensity expenditures for inter-industry input demands and intra-institutional transfers) as in matrix A_n and is chosen in such a way that its inverse exists, that is det $(I-A_0)^{-1} \neq 0$; $A^* = M_1 (A_n - A_0)$; n is a positive integer representing the order of decomposition, an integer greater or equal to 1(i.e. $n \geq 1$). The matrix A_0 with the same dimension as matrix A_n is chosen for the purpose of demonstrating that equation (5.1.4) can be written as stated.

Subtracting A_0Y from both sides of equation (a) gives

$$(I-A_0)Y = (A_n-A_0)\, Y + X \qquad (5.15)$$

$$Y = (I-A_0)^{-1}\, (A_n-A_0) + (I-A_0)^{-1}\, X \qquad (5.16)$$

Equation (5.16) can be written as follows

$$Y = (A^*)\, Y + M_1X \qquad (5.17)$$

where $M_1 = (I-A_0)^{-1}$, and $A^* = M_1(A_n-A_0)$. Solving for Y in equation 5.17 yields

$$Y = (I-A^*)^{-1}M_1X \text{ or } Y = (I-A^*)^{-1}\, I\, M_1X \qquad (5.18)$$

Equation (5.18) can be referred to as the first order decomposition where

$M_3 = (I-A^*)$ and $M_2 = I$.

The second order decomposition can be obtained the same approach as in the first decomposition. Multiplying both sides of equation (5.17) by A^* to give

$$A^*Y = (A^*)^2Y+A^*M_1X \tag{5.19}$$

Substituting $A^* Y$ in equation (5.17) for A^*Y to obtain

$Y= (A^*)^2Y + A^*M_1X+ M_1X$

$$Y= (I-(A^*)^2)^{-1}\ Y + (A^*+I)\ M_1\ X \tag{5.20}$$

Equation (5.20) is the second order decomposition where

$$M_3 = = (I-(A^*)^2)^{-1}\ ;\ M_2 = A^*+I \tag{5.21}$$

It can be shown that the above decomposition formula holds for n=3. In general, the formula for the (n-1)th decomposition can be expressed as

$$Y = \left(I-\left(A^*\right)^n\right)^{-1}\left[\sum_{i=n-1}^{1}\left(\left(A^*\right)^i+I\right)\right]M_1X \tag{5.22}$$

Equation (5.22) is the generalisation of the SAM multiplier decomposition with n partitions of matrix A.

For n =3, therefore

$$Y = \left(I-\left(A^*\right)^3\right)^{-1}\left(\left(A^*\right)^2+A^*+I\right)\left(I-A_0\right)^{-1}X \tag{5.23}$$

In this case

$$M_3 = (I-(A^*)^3)^{-1};\ \ M_2 = (A^*)^2+A^*+I;\ \ and\ M_1 = (I-A_0)^{-1} \tag{5.24}$$

Using matrices A_0 and A_n, matrices M_1, M_2, and M_3 can be obtained as follows

$$\text{Let } A_0=\begin{bmatrix} A_{11} & 0 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & A_{33} \end{bmatrix} \tag{5.25}$$

and det $(I-A_o)^{-1} \neq 0$;

$$A_n=\begin{bmatrix} A_{11} & 0 & A_{13} \\ A_{21} & 0 & 0 \\ 0 & A_{32} & A_{33} \end{bmatrix} \tag{5.26}$$

The elements of each cell in matrix, A_n can be summarised as follows

$$A_n = \begin{array}{c} \\ CA \\ FAC \\ H+F \end{array}\begin{vmatrix} CA & FAC & H+F \\ XX & 0 & XX \\ XX & 0 & 0 \\ 0 & XX & XX \end{vmatrix} \quad (5.27)$$

where

CA, *FAC*, and *H+F* represent production activities, factors and household and firms respectively XX represents cells with average expenditure propensities.

Thus, the M_1 matrix is given by

$$M_1 = (I\text{-}A_0)^{-1} = \begin{bmatrix} (I\text{-}A_{11})^{-1} & 0 & 0 \\ 0 & I & 0 \\ 0 & 0 & (I\text{-}A_{33})^{-1} \end{bmatrix} \quad (5.28)$$

M_1 is the matrix that captures direct transfers between endogenous accounts (i.e. production activities, and households) and is called the transfer multiplier matrix. Intuitively, M_1 captures the direct effects arising from transfers within the endogenous accounts (i.e. between production activities and households). It is referred to as the transfer multiplier.

Similarly, M_2 is given by

$$M_2 = I + A^* + A^{*2} \quad (5.29)$$

where

$A^* = M_1(A_n\text{-}A_0) = \begin{bmatrix} 0 & 0 & A^*_{13} \\ A^*_{21} & 0 & 0 \\ 0 & A^*_{32} & 0 \end{bmatrix}$; where $M_1 = (I\text{-}A_0)^{-1}$ and

$A^*_{13} = (I\text{-}A_{11})^{-1}A_{13}$; $A^*_{21} = A_{21}$; $A^*_{32} = (I\text{-}A_{33})^{-1}A_{32}$.

$$\text{and } A^{*2} = A^*A^* = \begin{bmatrix} 0 & A^*_{13}A^*_{32} & 0 \\ 0 & 0 & A^*_{21}A^*_{13} \\ A^*_{32}A^*_{21} & 0 & 0 \end{bmatrix}; \quad (5.30)$$

Solving for M_2 yields

$$M_2 = \begin{bmatrix} I & A^*_{13}A^*_{32} & A^*_{13} \\ A^*_{21} & I & A^*_{21}A^*_{13} \\ A^*_{32}A^*_{21} & A^*{}_{32} & I \end{bmatrix} \quad (5.31)$$

where

$A^*_{13} = (I\text{-}A_{11})^{-1} A_{13}$; $A^*_{21} = A_{21}$; and $A^*_{32} = (I\text{-}A_{33})^{-1} A_{32}$.

M_2 (second decomposition matrix) is the matrix that captures the cross effects of the multiplier process whereby a shock into one part of the social economic system has effects on other parts without the shock returning to its original destination (i.e. production to factors, institutions, and to commodities). These effects are referred to as open loop effects. M_2 therefore approximates Type II closed input-factor income/GDP multipliers. For example, an increase in agricultural and non-agricultural production leads to increase in factor demand and factor incomes (Figure 5.9.1).

Let us define the matrix M_3 as follows

$$M_3 = (I\text{-}(A^*)^3)^{-1} \quad (5.32)$$

Where $(A^*)^3 = (A^*)^2 A^*$

$$\text{Thus, } (A^*)^3 = (A^*)^2 A^* = \begin{bmatrix} A^*_{13}A^*_{23}A^*_{21} & 0 & 0 \\ 0 & A^*_{21}A^*_{13}A^*_{32} & 0 \\ 0 & 0 & A^*_{32}A^*_{21}A^*_{13} \end{bmatrix} \quad (5.33)$$

$$M_3 = \begin{bmatrix} (I - A^*{}_{13}A^*{}_{23}A^*{}_{23})^{-1} & 0 & 0 \\ 0 & (I - A^*{}_{21}A^*{}_{13}A^*{}_{32})^{-1} & 0 \\ 0 & 0 & (I - A^*_{32}A^*_{21}A^*_{13})^{-1} \end{bmatrix}$$

(5.3.4)

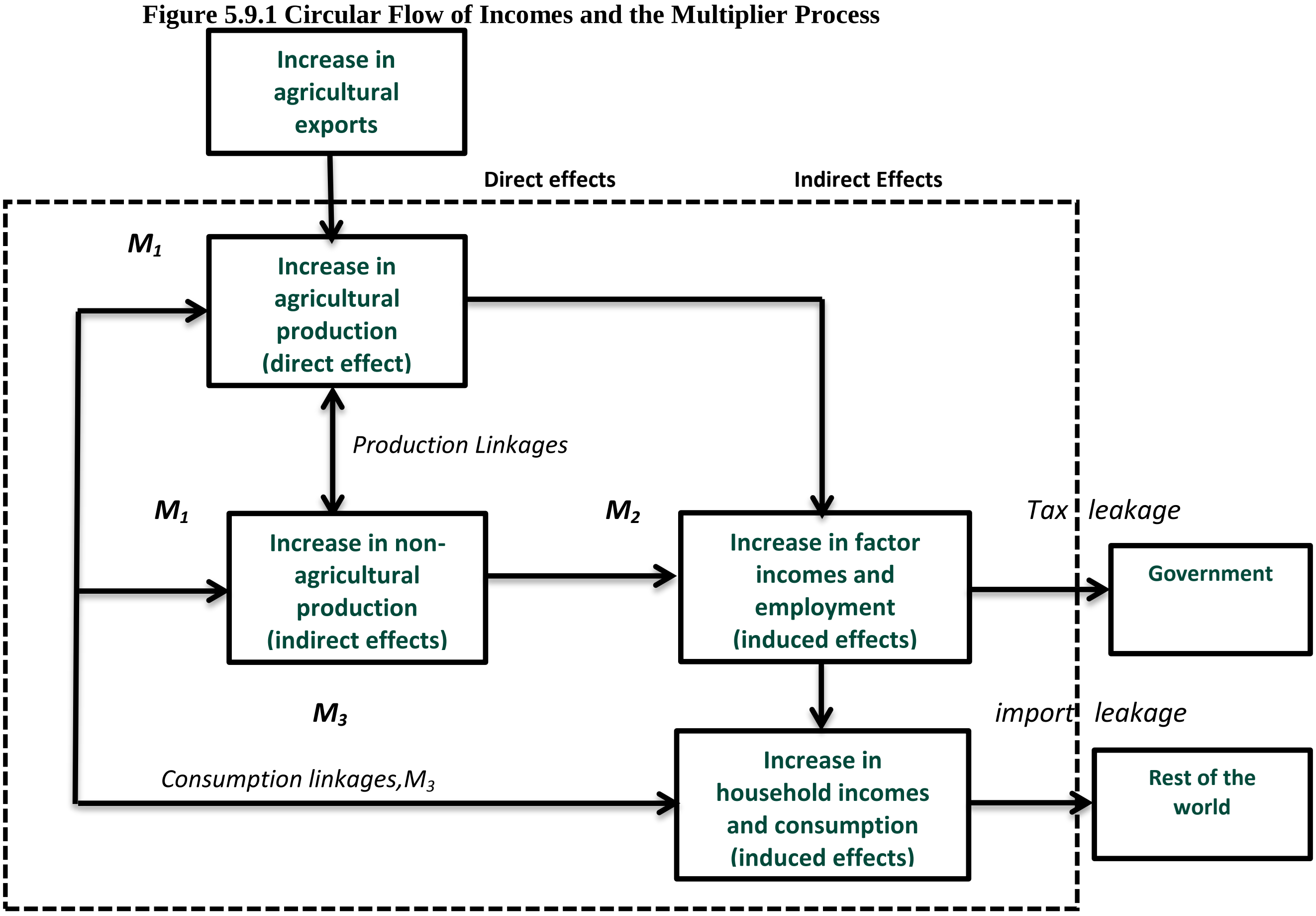
The matrix M_3 completes the circular flow of income and captures the closed loop effects. That is, the circular flow of income is completed among endogenous accounts (i.e. from production activities to factors, to institutions back to activities in form of consumption, demand, income etc.). For example, the increase in factor incomes (from M_2) stimulates demand for goods and services (consumption linkages) which leads to increase in household consumption. The circular flow of income is completed when the increase in household incomes and consumption leads to further increase in production of goods and services, i.e. induced effects (Figure 5.9.1). The multiplier matrix M_3 approximates Type II closed input-output income multipliers.

5.9 The Additive Decomposition of Matrix, M_a

Because the matrices (i.e. M_1, M_2, and M_3) enter the decomposition formula multiplicatively, the net contribution of each effect to total income in the whole economy is difficult to explain (Tarp, Roland-Holst, and Rand 2002). To overcome this problem, Stone (1978) proposed an additive decomposition of the multiplier matrix, M_a into four other matrices or components (M_1, M_2, M_3, and I). This additive decomposition enables the policy modeller to identify the contribution of each account to the total multiplier and to classify SAM multipliers as Type I and Type II multipliers (Figure 5.9.1).

To explain the difference between Type I and Type II multipliers, suppose that there is an increase in production (output) by activity, *A* in region R. To increase its output, activity A must of course employ additional labour, for example 100 employees. But for A to increase its output it must acquire additional inputs from other activities, some of them within the region; i.e., activities B, C, etc., will be require to supply additional inputs to A. Suppose that this will require those within-region activities that supply additional inputs to activity A to hire 50 more employees. At this point, the increase in employment that has occurred because of the increase in A's output is 150 employees – this is the direct employment effect of the increase in activity A's output. There are further employment effects of activity A's increase in output, because the increased output of those activities that supply A means that they must, in turn, acquire more inputs, which means that their suppliers (within the region) must hire additional employees. This is called the indirect employment effect of the increase in activity A's output. Thus, Type I employment multiplier measures the direct and indirect effects of a change in output by a particular regional economic activity on total employment in the region.

Figure 5.9.1 Circular Flow of Incomes and the Multiplier Process



Source: Breisinger *et al.*, (2009). Modified by Author. M_1 is Output multiplier matrix; M_2 is GDP or value added multiplier matrix; M_3 is the matrix that approximates institutional income multipliers.

Type I multipliers help us to understand Type II multipliers. Part of the income earned by employees above will be spent again within the region's economy, which will generate further employment and income (induced effect). Thus, to get Type II multipliers, we add the induced effect to Type I direct and indirect effects of the shock discussed above.

Thus, the SAM accounting multiplier matrix M_a is an approximation of Type II closed input-output multipliers.

In general,

$$M_a = (M_3 - I)M_2M_1 + (M_2 - I)M_1 + (M_1 - I) + I \tag{5.35}$$

$$= C + O + T + I$$

Therefore, we can write $Y = M_a X$ as

$$Y = (C + O + T + I) X \tag{5.36}$$

I is the initial injection (identity multiplier) that shows the effect of an injection into one account which amounts to an income increase that is similar to the original injection,

$T = (M_1 - I)$ is the net transfer multiplier and measures the net intra-group effect or within account effects where the original injection took place.

$O = (M_2 - I)M_1$ is the open loop multiplier and measures the net extra group effects or net cross effects arising out of an initial injection when it has completed a tour outside the original account without returning to that account;

$C = (M_3 - I)M_2M_1$ is the closed loop multiplier and measures the net contribution of circular effects or net inter-group effects which arises when the original injection circulates through all the accounts and goes back to the original account.

Note that the size of a multiplier depends on the structural characteristics of an economy being studied. For example, a key determinant is the share of imported goods and services in private consumption demand. If households consume domestically produced goods, then increasing household incomes will benefit domestic producers and the circular flow of income will lead to further rounds of indirect linkage effects. However, if private consumption is dominated by a large share of imported goods, then it is foreign producers who benefit and the indirect linkage effects would be smaller. Import demand is therefore a leakage from the circular flow of income (Figure 5.9.1). Similarly, when the government taxes factor incomes, it limits how much of the returns to production are earned by households, and so reduces consumption linkages. Consequently, taxes and imports make the round-by-round effects slow down more quickly and reduce the total multiplier effect.

If the origin and destination accounts are in different account blocks, transfer effects would be zero. In addition, if a sector has large transfer multiplier effects and small closed loop or total effects after the shock, this might suggest that the sector is highly integrated but has weak forward linkages (Roland-Holst and Sancho, 1995). If the shock origin and destination sectors belong to the same account block, open loop effects would be zero. Large open loop or transfer effects between two sectors are indicative of a higher degree of dependence of the destination sector on the sector where the shock originated. Table 5.9.1 gives a summary of scenarios regarding the origin and destination of the shock, and the magnitude of the multiplier effects that are generated for any given exogenous shock to the SAM.

Table 5.9.1 Origin of Shock, Transfer, Open and Closed Loop Effects

Sector classification and origin of shock	Transfer effects	Open loop effects	Closed/total loop effects
Origin and destination sectors belong to different account blocks	All zero	Not zero	Not zero
Origin and destination sectors belong to same account block	Not zero	All zero	Not zero

Source: Roland-Holst and Sancho (1995).

5.10 SAM Multiplier Decomposition Applied to Uganda

5.10.1 Experiment 1. A 30% Increase in Agriculture Commodity Exports

This simulation is equivalent to an injection of shillings 87,969 million to the base value of agriculture exports. The size of this shock was chosen because coffee and fish which dominate traditional and non-traditional exports in Uganda increased by 20 percent on average between 2002 and 2005[20]. We analyse the sectoral effects of a further 30 percent increase in agricultural exports. The effects of this experiment on sectoral output are presented in Table 5.10.1 below.

[20] Statistical Abstracts (2005, 2006) and Bank of Uganda Annual Reports, 2009/2010.

Table 5.10.1 Effects of 30% Increase in Agricultural Exports on Sectoral Output

	Transfer effects (%)	Open Loop effects (%)	Closed Loop effects (%)	Total effect (%)
Agriculture	2.69	0	1.30	3.99
Mining	0.03	0	0.72	0.75
Food Proc.	0.07	0	1.17	1.24
Manufacturing	0.14	0	0.92	1.06
Utilities	0.06	0	1.32	1.38
Construction	0.01	0	0.19	0.20
Trade Service	0.14	0	1.25	1.39
Transport	0.17	0	1.15	1.32
Educ & Health	0.07	0	0.79	0.86
Other Service	0.05	0	0.90	0.95
Domes. Prod'n	0.57	0	0.98	1.55
Total Supply	0.13	0	0.98	1.21

Source: Own computations. SAM Multiplier Model.

Increasing agriculture exports by 30 percent and accounting for all direct and indirect linkage effects increases total domestic production and supply by 1.6 percent of 0.98 percent (or 63 percent of the total) is due to closed loop or feedback effects and 0.57percent (or 37 percent of the total) is due to transfer multiplier effects. Similarly, domestic supply increases by 1.2 percent of which 0.98 percent (or 81 percent of the total) is due to closed loop effects and 0.13 percent (or 19 percent) is due to transfer effects. Increasing agriculture exports leads to an increase in agriculture's own production by 4 percent of which 2.7 percent is due to transfer effects and 1.3 percent is closed due to closed loop effects. The production of processed foods increases by 1.24 percent of which 0.07 percent is due to transfer effects and 1.17 percent is due to closed loop effects. Overall closed loop multipliers are larger than transfer multipliers because they include both production and consumption linkages. Increasing agriculture exports and accounting for all indirect and direct linkage effects increases the output of Trade Services by 1.4 percent, Utilities by 1.4 percent, Transport by 1.3 percent and Manufacturing by 1.1 percent. Large feedback or closed loop effects and small transfer effects point to the fact that agriculture (the source of the injection) has strong forward linkages with rest of the economy (Roland-Holst and Sancho, 1995). Open loop effects for production activities are all zero because the source (activities) and destination of the injection belong to the same account block (production block). On the other hand, the dominance of closed loop effects might imply that Uganda's economy is not strongly linked (Nganou, 2005). The effects of increasing agriculture exports on factor and household incomes are summarised in Tables 5.10.2 and 5.10.3 below.

Table 5.10.2 Effect of 30% Increase in Agricultural Exports on Factor Incomes

Factor incomes	Transfer effects (%)	Open-loop effects (%)	Closed loop effects (%)	Total effect (%)
Low skilled-r-male	0	2.03	1.20	3.23
Low-skilled-r-female	0	1.85	1.18	3.02
Low skilled-urb-male	0	0.41	0.97	1.38
Low skilled-urb-female	0	0.26	1.12	1.38
High skilled-r-male	0	0.24	0.82	1.06
High skilled-r-female	0	0.24	0.89	1.13
High skilled-urb-male	0	0.12	0.93	1.05
High skilled-urb-female	0	0.07	0.92	0.99
Capital	0	0.88	1.00	1.89

Source: Own Computations. SAM Multiplier Model Results. rur: rural; urb: urban.

Table 5.10.3 Effect of 30% Increase in Agricultural Exports on Household Incomes

	Transfer effects (%)	Open-loop effects (%)	Closed loop effects (%)	Total effect (%)
Central –rur- hhds	0	0.76	0.90	1.67
Central-urb-hhds	0	0.59	0.92	1.51
Eastern-rur-hhds	0	0.75	0.87	1.62
Eastern-urb-hhds	0	0.45	0.82	1.28
Northern-rur-hhds	0	0.7	0.86	1.56
Northern-urb-hhds	0	0.38	0.82	1.21
Western-rur-hhds	0	0.85	0.94	1.79
Western-urb-hhds	0	0.59	0.95	1.54

Source: Own Computations. SAM Multiplier Model Results. rur: rural; urb: urban

An increase in agriculture exports is associated with an increase in factor incomes. The incomes of rural based low skilled labour increases by 3 percent while the incomes of low skilled urban based labour increases by 1.4 percent following the injection. Rural incomes dominate because agriculture in Uganda is predominantly a rural based activity and the largest employer of low skilled labour (Uganda Human Development Report, 2007). Increasing agriculture exports increases household incomes. Rural based households benefit more than their urban based counterparts. The increase in incomes of rural households is in the range of 1.6 percent to 1.8 percent. For urban households, the increase is between 1.2 percent and 1.5 percent respectively. Regionally, western based households experience the largest increase in incomes. The increase is in the range of 1.5 percent and 1.8 percent followed by central and eastern region households of 1.3 percent and 1.7 percent respectively. The concentration of agricultural activities in western and central regions could partly explain why the shock to agriculture exports increases factor and household incomes in these regions. Transfer effects for factors and institutions are zero because the source of the injection (production) and destination (institutions) belong to different account blocks in the SAM (Roland-Holst and Sancho, 1995).

5.10.2 Experiment 2. Effects of a 50 Percent Increase in Migrant Remittances

This experiment is equivalent to an injection of Uganda shillings 334,476 million to the base value of remittances. The effect of an increase in migrant remittances on sectoral output is summarised in Table 5.11.1 below.

Table 5.11.1 Effect of a 40% Increase on Migrant Remittances on Sectoral Output

	Transfer effects (%)	Open-loop effects (%)	Closed loop effects (%)	Total effect (%)
Agriculture	0	2.83	3.39	6.22
Mining	0	1.52	1.88	3.40
Food Processing	0	2.57	3.09	5.66
Manufacturing	0	1.90	2.43	4.33
Utilities	0	2.82	3.47	6.29
Construction	0	0.33	0.52	0.85
Trade Service	0	2.68	3.29	5.97
Transport	0	2.39	3.05	5.44
Education & Health	0	1.59	2.12	3.72
Other Service	0	1.79	2.42	4.20
Domes. production	*0*	*2.04*	*2.58*	*4.62*
Total supply	*0*	*1.69*	*2.14*	*3.84*

Source: Own Computations. SAM Multiplier Model Results.

Increasing migrant remittances increases total production by 4.6 percent of which 2 percent (about 44.2 percent) is due to transfer effects and 2.6 percent (55.8 percent of the total) corresponds to feedback or closed loop effects. Similarly, total domestic supply increases by 3.8 percent as a result of the shock. Increasing migrant remittances increases agriculture’s output by 6.2 percent of which 2.8 percent is due to open loop effects and 3.4 percent is due to closed loop/feedback effects. Increasing migrant remittances significantly increases the output of utilities by 6.3 percent, followed by Trade Services (6 percent), and processed food products (5.7 percent). Transfer effects are zero because the origin of the shock (institutions) and its destination (production activities) belong to different account blocks in the SAM. The impact of migrant remittances on factor and household incomes is presented in Table 5.11.2 and 5.11.3 below.

Table 5.11.2 Effect of Increase Migrant Remittances on Factor Incomes

Factor Incomes	Transfer effects (%)	Open-loop effects (%)	Closed loop effects (%)	Total effect (%)
Low skilled-r-male	0	2.58	3.13	5.70
Low-skilled-r-female	0	2.51	3.08	5.59
Low skilled-urb-male	0	2.02	2.56	4.58
Low skilled-urb-female	0	2.39	2.96	5.35
High skilled-r-male	0	1.67	2.19	3.86
High skilled-r-female	0	1.80	2.37	4.17
High skilled-urb-male	0	1.88	2.48	4.37
High skilled-urb-female	0	1.87	2.47	4.34
Capital	0	2.11	2.64	4.75

Source: Own Computations. SAM Multiplier Model Results.

Table 5.11.3 Effect of Increased Migrant Remittances on Household Incomes

	Transfer effects (%)	Open-loop effects (%)	Closed loop effects (%)	Total effect (%)
Central –rur- households	0.45	0	4.27	4.72
Central-urb-households	0	0	4.36	4.36
Eastern-rur-households	0.5	0	4.1	4.60
Eastern-urb-households	0.21	0	3.88	4.08
Northern-rur-households	0.79	0	4.06	4.85
Northern-urb-households	0.2	0	3.88	4.09
Western-rur-households	0.08	0	4.45	4.53
Western-urb-households	0	0	4.47	4.47

Source: Own Computations. SAM Multiplier Model Results. rur: rural; urb: urban.

The increase in migrant remittances significantly increases household and factor incomes. This can be explained as follows: the increase in household incomes caused by an increase in migrant remittances leads to an increase in production activities which in turn increases factor incomes. For factors, the largest beneficiaries are rural and urban based low skilled labour. Their income increase is within the range of 4.6 percent and 5.7 percent. For households, the most affected are rural based and their incomes vary between 4.5 and 4.9 percent. Transfer effects are zero for factors because the origin of the shock (institutions) and its destination (production activities) belong to different account blocks in the SAM. The increase in household income is slightly more for households resident in the central and western regions compared to other household groups. Open loop effects are zero for households because the origin of the shock (institutions) and destination (households) belong to the same account block in the SAM.

5.10.3 Experiment 3. The Impact of a 50% Decrease in Import Tax Revenues

SAM multiplier models are known to be demand based and cannot be used to study the impact of supply side shocks such as trade liberalization. However, one can assume that a reduction in tariff rates is identical to a reduction in government tariff revenue and thereafter examine the effects of this shock as a demand side shock. This experiment is made possible because the Uganda SAM was constructed in such a way that all taxes, including import taxes are collected and transferred to the core government account which is assumed to be exogenous in the SAM multiplier analysis. To perform this experiment, government is made endogenous and the multiplier matrix M_a is re-estimated.

The effects of a 50 percent decline in import tax revenues on sectoral output are presented in Table 5.12.1 below. Note that this experiment is equivalent to a decrease in the base value of government revenue shillings by 192,740 million.

Table 5.12.1 Effect of a 50% Decrease in Import Tax Revenue on Sectoral Output

	Transfer effect (%)	Open-loop effects (%)	Closed loop effect (%)	Total effect (%)
Agriculture	0	-0.13	-1.92	-2.05
Mining	0	-0.19	-1.07	-1.27
Food Processing	0	-0.14	-1.76	-1.90
Manufacturing	0	-0.49	-1.40	-1.89
Utilities	0	-0.57	-1.99	-2.56
Construction	0	-0.18	-0.30	-0.48
Trade Service	0	-0.36	-1.87	-2.24
Transport	0	-0.51	-1.75	-2.25
Education & Health	0	-3.55	-1.34	-4.89
Other Service	0	-2.20	-1.46	-3.65
Total domestic Prod	0	-1.06	-1.50	-2.56
Total supply	0	-0.99	-1.50	-2.49

Source: Own computations. SAM Multiplier Model Results.

Decreasing import tax revenues leads to a decrease in output for all sectors as well total domestic production and supply. The output of Education and Health Service declines by 4.9 percent, followed by Other Services (3.7 percent), Electricity and Water (2.6 percent), Trade Service (2.2 percent), and Agriculture (2.1 percent).

Overall, circular effects or closed loop multipliers dominate because they include direct and indirect linkage effects. Transfer effects for production activities are zero because the source of the injection (tax collection account) and destination account (activities) belong to different account blocks in the SAM (Roland-Holst and Sancho, 1995). The impact of reduced tariff revenues on factor and household incomes are presented in Table 5.12.2 and Table 5.12.3 below.

Table 5.12.2 Effect of 50% Decline in Import Tax Revenue on Factor Incomes

Factor Incomes	Transfer effect (%)	Open-loop effects (%)	Closed loop effects (%)	Total effect (%)
Low skilled-r-male	0	-0.38	-1.86	-2.24
Low-skilled-r-female	0	-0.72	-1.84	-2.56
Low skilled-urb-male	0	-0.86	-1.55	-2.41
Low skilled-urb-female	0	-0.61	-1.78	-2.38
High skilled-r-male	0	-2.40	-1.39	-3.78
High skilled-r-female	0	-2.55	-1.50	-4.05
High skilled-urb-male	0	-1.85	-1.54	-3.39
High skilled-urb-female	0	-2.30	-1.55	-3.85
Capital	0	-0.73	-1.59	-2.32

Source: Own computations. SAM Multiplier Model Results.

Table 5.12.3 Impact of Tariff Cuts on Household Incomes

	Transfer effect (%)	Open-loop effects (%)	Closed loop effects (%)	Total effect (%)
Central -r- households	0	-0.11	-2.38	-2.48
Central-urb-households	0	-0.11	-2.53	-2.64
Eastern-r-households	0	-0.11	-2.24	-2.35
Eastern-urb-households	0	-0.11	-2.37	-2.48
Northern-r-households	0	-0.1	-2.49	-2.6
Northern-urb-households	0	-0.08	-2.48	-2.57
Western-r-households	0	-0.08	-2.45	-2.53
Western-urb-households	0	-0.07	-2.58	-2.65

Source: Own computations. SAM Multiplier Model Results.

The impact of reduced import tax revenue on factor incomes is such that both categories of labour experience a decline in their incomes. Our findings suggest that high skilled labour categories would be most affected by the shock compared to low skilled labour categories. The incomes of rural based high skilled females and urban based high skilled male workers decreases by 4.1 percent and 3.9 percent respectively. Overall, a decrease in import tax revenue by 50 percent decreases incomes of rural and urban based high skilled labour by between 3.4 percent and 4.1 percent respectively. For high skilled labour (i.e. destination account), open loop effects are the most important and account for approximately 2 percent to 2.6 percent of the decline in income. Transfer effects for production activities and factors all are zero since the origin of the shock (tax collection account) and destination account (activities) are in different account blocks in the SAM (Roland-Holst and Sancho, 1995).

The decline in household incomes across all household groups following the decline in import tax revenue is between 2.35 percent and 2.65 percent. Generally urban based households experience the largest decline in their incomes. By residence and region, the decline in incomes is as follows: Western urban (2.65 percent), central urban (2.64 percent), and eastern urban households (2.57 percent). In rural areas, northern based households experience the largest decline in incomes of 2.6 percent after the shock followed by western rural households at 2.53 percent.

5.13 SAM Modeling: Computing Changes in Employment

The derivation of employment changes from the SAM multiplier model is not all straight forward. However, with the use of some reasonable assumptions, we could get an approach that yields employment changes. As stated earlier, the SAM multiplier model assumes fixed prices. This assumption is reasonable if inter-industry technology follows Leontief assumptions so that there are no scale effects, and prices are given for certain indirect taxes and that import prices are fixed and factor costs per unit of output are constant (Pyatt and Round, 1979). In addition, labour cost per unit of output is constant if labour is paid at fixed wage rates. If wages and prices are fixed before and after the shock, it would be difficult to compute the changes in employment resulting from changes in input and output prices since this means that changes in prices directly imply changes in quantity of output. We can therefore assume that each activity produces a level of output QA_a that is directly proportional to its employment or demand for factor inputs, $QF_{f,a}$. The resulting output-input ratio

k is assumed to remain constant before and after the policy shock. Thus, changes in activity level or output, QA_a are due to changes in factor employment, $QF_{f,a}$ i.e.

$$QA_a \propto QF_{f,a}\,;\; k = \frac{QA_a}{QF_{f,a}} = \frac{output}{factor\ employment} \tag{5.37}$$

By similar reasoning and given the linearity assumption of the SAM multiplier model,

$$k = \frac{\Delta QA_a}{\Delta QF_{f,a}} = \frac{Change\ in\ output}{Change\ in\ \ factor\ demand\ by\ each\ activity\,/\,employment} \tag{5.38}$$

To compute the change in employment using the SAM multiplier model (i.e. change in the number of jobs created or lost as a result of the shock), we arrange the expression for the constant k in such a way that the output-input ratio remains unchanged as follows:

$$\Delta QF_{f,a} = \frac{\Delta QA_a}{k} \;\; \text{; and } \; \Delta QA_a \in M_a dx \tag{5.39}$$

where M_a and dx are the accounting multiplier matrix and the shock vector corresponding to a selected exogenous policy change; and ΔQA_a is the change in output due to the shock.

However, other studies (Nganou, 2005) have demonstrated that if wages were fixed and the average product of labour is constant, then labour incomes would be proportional to employment levels. Therefore, if we knew the official employment data that were used to generate value added in the SAM, then the average wage rate for labour would simply be the ratio of total labour income to initial employment. This average wage rate could therefore be used as the fixed labour unit cost to compute changes in employment in all simulations. Given that the calculated wage rate (W) is assumed to remain constant and the change is labour ($\Delta lbrinc$) is obtained through the multiplier process, then the change in employment is simply the ratio of the change in labour income and wage rate. Let the initial labour income be denoted by $lbrinc_0$. This can be obtained from the row totals of the factor sub account-labour. Let E_0 be the initial employment used to generate value added in the SAM. The average wage (W) rate is given by:

$$W = \text{labour income/employment} = lbrinc_0 / E_0 \qquad (5.40)$$

$$\text{Employment } (E_0) = \text{labour income/wage} = lbrinc_0 / W. \qquad (5.41)$$

If the change in exogenous demand or policy generates a new labour income through the multiplier given $lbrinc_1$, since the wage rate is fixed, the new level of employment is given by E_1. The post shock change in labour income and change in employment ($\Delta Employment$) are given by:

$$\Delta lbrinc_1 = W^* \Delta E_1 \qquad (5.42)$$

The change in labour income due to the shock is given by

$$\Delta lbrinc_1 = lbrinc_1 - lbrinc_0 \qquad (5.43)$$

Similarly, the change in employment/number of jobs created is given by:

$$\Delta Employment = E_1 - E_0 \qquad (5.44)$$

From equation 5.42, the change in income is the product of the average wage rate and the change in employment. This further implies that

$$\Delta Employment = \Delta lbrinc / W \qquad (5.45)$$

The employment results presented in Table 5.13.1 indicate that the largest change in the total number of low and high skilled labour jobs is achieved with a 50 percent increase in workers remittances.

Table 5.13.1 SAM Multiplier Model: Impact of Experiments on Change in Employment

	PWE_INCR		*REMIT_INCR*		*TAR_CUT*	
Activity/Labour type	Low skilled	High skilled	Low skilled	High skilled	Low skilled	High skilled
Agriculture	94,617(13)	678	147,303 (5.1)	1,056	-48,523	-348
Mining	360 (0.05)	0	1,635 (0.1)	0	-609	0
Food Processing	112,179 (15.6)	3,551	513,489 (17.9)	16,252	-172,109	-5,447
Manufacturing	133,022 (18.4)	16,586	545,712 (19)	68,043	-238,117	-29,690
Electricity &Water	41,381(5.7)	111,661	188,821(6.6)	509,506	-76,741	-207,074
Construction	33,708 (4.7)	7,901	143,964 (5)	33,744	-81,432	-19,087
Trade Services	154,919 (21.5)	14,998	667,212 (23)	64,596	-250,192	-24,222
Transport	16,058 (2.2)	320	66,144 (2.3)	1,319	-27,396	-546
Health & Education	18,125 (2.5)	15,317	78,287 (2.7)	66,161	-103,044	-87,082
Other Services	116,732 (16.2)	21,198	515,379 (18)	93,592	-447,740	-81,309
Total	*721,101*	*192,211*	*2,867,946*	*854,268*	*-1,445,904*	*-454,806*

Source: Authors Calculations: SAM multiplier model results. *PWE_INCR*: 30% increase in Agric. commodity exports; *REMIT_INCR*: 40% increase in Worker's Remittances; *TAR_CUT*: A 40% Reduction in Import Tariff Revenue. Figures in parentheses are shares in total employment of low skilled labour.

An increase in the value of agriculture commodity exports by 30 percent (*PWE_INCR*) results into a significant change in employment of low skilled labour. The change in employment is 721,101 jobs for low skilled labour compared to 192,211 jobs for high skilled labour. The change in employment of low skilled labour is highest for Trade Services (154,919 jobs) followed by Manufacturing (133,022 jobs), Other Services (116,732 jobs), Food Processing (112,179 jobs), and Agriculture (94,617 jobs). The change in employment is lowest in Mining, Construction, Transport, Services, and Utilities and range between 306 jobs to 41,381 jobs a result of the shock. Meanwhile, the change in employment of high skilled labour is highest in the Utilities sector (111,661jobs) followed by Other Services (21,198 jobs), Manufacturing (16,586 jobs), Education and Health (15,317 jobs), and Trade Service (14,998 jobs).

Increasing workers remittances by 50 percent (*REMIT_INCR*) changes the employment of low and high skilled labour by between 0.85 million to 2.9 million jobs. The change in employment of low skilled labour is highest for Trade Services (667,212 jobs), followed by Manufacturing (545,715 jobs), Other Services (515,379 jobs), and Food Processing (513,489 jobs). Mining, Transport, Health and Education, Construction, and Agriculture sectors registered changes in employment of low skilled labour of between 66,000 jobs to 150,000 jobs. For high skilled labour, the highest change in employment occurs in the Utilities sector (510,000 jobs), followed by Other Services (93,592 jobs), Manufacturing (68,043 jobs), Health and Education (66,161 jobs), and Trade Services (64,596 jobs). Agriculture (1,056 jobs) and Transport (1,319 jobs) registered the lowest change in employment of high skilled labour as a result of the injection.

The decline in important tariff revenue (*TAR_CUT*) causes a significant decline in employment of low skilled labour. Sectors with significant low skilled labour job losses include: Other Service (448,000 jobs), Trade Services (-250,000 jobs), Manufacturing (-238,000 jobs), Food Processing (-172,000 jobs) and Education and Health (-103,000 jobs).

Compared to other sectors, agriculture (-48,523 jobs), Transport (-27,396 jobs), and Mining (-610 jobs) lost fewer low skilled labour jobs. For high skilled labour, utilities had the highest number of job losses (-207,074 jobs), followed by Health and Education (-87,000 jobs), Other Service (-81,000 jobs), Manufacturing (-29,690 jobs), and Trade Service (-24,222 jobs), and Construction (-19,087 jobs). Mining did not register any job losses. Agriculture (-348 jobs), Transport (-546 jobs), and Food Processing (-5,447 jobs) registered the lowest number of job losses for high skilled labour after the shock.

5.14 Conclusion

Using the 2002 Social Accounting Matrix for Uganda, we investigated the properties of the multipliers that can be calculated from the SAM. The calculated forward and backward linkages suggest that Agriculture, Other Services, Food Processing, and Trade Service are the key sectors of Uganda’s economy. Manufacturing, Transport, Utilities, and Construction sectors have weak forward and backward linkages. Exogenous changes performed with the SAM multiplier model suggest that the agriculture sector is associated with significant employment, factor and household incomes, and could therefore be targeted for growth and poverty alleviation in Uganda.

This analysis is based on the SAM multiplier model which operates under unrealistic assumptions. First, the model is demand driven and completely ignores issues of resource allocation, productivity, and factor utilization. With the assumption of fixed coefficients, the model ignores substitution possibilities in consumption, production, imports and exports triggered by changes in relative prices. The SAM multiplier model ignores possibilities for partial shifting of the incidence of taxes, tariffs and subsidies through interaction between supply and demand. The SAM multiplier model assumes the excess capacity where the economy operates below its production possibility frontier. However, in the real world, at least some sectors operate under full capacity and some factors (i.e. skilled labour) are fully employed. Under such conditions, prices can no longer be assumed to remain constant. However, some findings can be justified for a smaller and dependant Ugandan economy.

This dissertation addresses the limitations of the SAM multiplier model by developing a more powerful tool (i.e. a CGE model) that takes into account price changes and other optimizing behaviour in the description of the various institutions in the SAM. The CGE model allows for flexibility in production and demand functions. If this model is simulated, it is able to capture the workings of a market economy (i.e. price changes, factor substitution, thus providing a framework for analysing the impact of exogenous changes and policies on the socioeconomic system. In CGE models, most of the prices are endogenously determined so as to generate the set of prices that are consistent with equilibrium in an economy. When the economy is affected by an exogenous shock, or policy change, a new set of prices is obtained, which in turn determine the production, consumption, employment and income levels of different institutions and factors. The next chapter discusses the structure of the computable general equilibrium (CGE) model for Uganda.

Chapter Six

The Structure of the CGE Model for Uganda

6.1 Background and Motivation

Computable General Equilibrium (CGE) models may be defined as completely specified models of an economy or region which includes production activities, factors, and institutions, macroeconomic components such as, investment and savings, balance of payments, and government budget constraint[21]. These models include the modeling of all markets in which the decisions of agents are price responsive and markets are assumed to be in equilibrium. In addition, these models provide a comprehensive account of the circular flow of payments in an economy.

CGE models are widely used in economic policy analyses in developing countries. These models possess a comparative advantage in the analysis of exogenous policies that link different production sectors in an economy. The most popular use of CGE models is the analysis of the impact of various policies on household welfare, income distribution, and sectoral linkages in developing countries (Lofgren *et al.,* 2001; Thorbecke *et al*., 1991; De Janvry *et al*., 1991; and Morrison, 1999). One advantage of these models is that there are structural, requiring no identification and allows the modeler or policy maker to alter economic aggregates to study the impact of various policies (Peterson, 2003). Based on this strand, we develop a CGE model and apply it to the salient features of Uganda's economy. The model is calibrated to the 2002 Social Accounting Matrix for Uganda. The model is then used to estimate the effects of selected exogenous changes and policy shocks on Uganda's economy.

[21] See Dervis *et al*., (1982); Shoven and Whale (1992).

6.1.1 SAM based CGE Models and Welfare Analyses

SAM based computer general equilibrium models for analysing the impact of external shocks and policies on poverty and welfare have been widely applied in developing countries. Early studies include: South Korea (Adelman and Robinson, 1979); and Brazil (Lysy and Taylor, 1980). Over the last twenty years, the increasing interest in the welfare of the poor has seen an increase in CGE-based welfare analyses in many developing economies. These studies are either regional or country specific. Regional studies include: Eastern and Southern Africa (Dorosh and Diao, 2007); Sub-Saharan Africa (Dorosh and Haggblade, 2003); and an archetype African economy (Chia *et al*., 1994, and Decaluwe *et al*., 1999). Country specific studies include: Tanzania and Zambia (Thorbecke and Jung 2003); South Africa (Thurlow and Seventer, 2002, and Khan, 1999); Madagascar (Cogneau and Robilliard, 2001); Malawi (Lofgren *et al*., 2001); Nepal (Cockburn, 2001); Mexico (Harris, 2001; and Serra-Pusche *et al*., 1984); Ghana (Colatei and Round, 2000); Zimbabwe (Bautista and Matthews, 1999); the Philippines (Bautista and Marcella, 1997); Indonesia (Abbink *et al*., 1995; Thorbecke, 1991; and Ravallion and Van de Walle; 1991); and Ecuador (De Janvry and Sadoulet, 1991). Specific studies that have analysed Uganda's economy using SAM-based CGE models include: (Thurlow and Dorosh, 2009; Matovu *et al*., 2009; Boysen *et al*., 2008; Lindsay *et al*., 2008; Dorosh *et al*., 2002; and Mbabazi, 2002). Following these studies, we develop a CGE model calibrated to the social accounting matrix for Uganda. The model is then simulated with exogenous changes and policy variables to identify sources for growth and poverty alleviation in Uganda.

6.1.2 Features of the CGE Model for Uganda (CGE_UGA1)

The CGE model for Uganda adopts the IFPRI Standard Computational General Equilibrium Model in GAMS (Löfgren *et al*.; 2002). The model is a static, non-monetary, single country model. All representative agents optimize – rationally and fully informed – their individual benefits resulting in a market-cleared, no-profit equilibrium. Producers (activities) maximize profits subject to the available production technology and input prices. The final commodity outputs are produced by combining quantities of value-added and aggregate intermediate inputs.

Profit maximization behaviour of producers is ensured by the first-order optimality condition. Requiring that each factor's marginal productivity is equal to its remuneration, i.e. wage or rent. As long as a factor is fully mobile, its wage is the same across all sectors. The representative institutions of the model are households, the corporation, government, and the rest of the world.

The household receives its income from the factors of production and from transfers from the government and the rest of the world. It consumes commodities pays direct taxes and saves the remaining income. The government receives income from collecting income, commodity, and import taxes as well as from transfers from the rest of the world. The government consumes a fixed quantity of private and public services, and investments. Additionally, it transfers amounts that are indexed to the CPI to households. Finally, the rest of the world receives payments from imports to Uganda and spends for exports from Uganda, transfers to Ugandan households, and investments. Foreign savings is defined as the difference between rest of the world incomes and spending.

Commodity markets are modelled as follows. Aggregate quantity of domestic output is allocated to domestic sales and exports assuming imperfect transformability using a constant elasticity of transformation (CET) function designating output shares exclusively to domestic or export sales. Quantity of output produced and sold domestically and imports are perceived by consumers as imperfect substitutes. The model uses a CES aggregation function to transform domestic products and their imported substitutes according to consumer preferences into one final composite commodity. This Armington function prevents unrealistic total shifts towards either imports or domestic production following a relative price change. The use of CES and CET functions enables the Ugandan model to identify ways in which demand for imports and exports of key sectors (e.g. agriculture and industrial exports) can strengthen or weaken the linkages between growth and poverty alleviation (Thurlow *et al*., 2008). Production and consumption decisions are captured by linear and non-linear first order optimality conditions. The model equations also include a set of constraints that have to be satisfied by the system as a whole but which are not necessarily considered by any individual actors. These constraints cover markets for factors and commodities, and macroeconomic aggregates (i.e. balances for savings and investment, government, and the current account of the rest of the world).

The price domestic suppliers of exports receive is equal to the world price in domestic currency net of transaction costs to the border. The price paid by domestic demanders is given by producer prices net of transaction costs. Domestic demand is composed of household and government consumption, investment demand, and intermediate inputs. Demands and supplies on the various markets are required to equilibrate through adjustment of prices. Following from the small country assumption, international supplies and demands are infinitely elastic at given world prices.

The model for Uganda is a standard static Walrasian neo-classical specification and follows in the tradition of application of CGE models in developing countries (Dervis *et al*. 1982) and standard CGE modelling frameworks (Blake *et al*. 1998). It is Walrasian because equilibrium in *n* markets is assured by equilibrium in

(n-1) markets[22]. The model is solved in a comparative static mode. It provides a simulation laboratory for conducting controlled experiments, changing policies and other exogenous conditions, and measuring the impact of these exogenous changes. Each solution provides a full set of economic indicators, including household incomes, prices, supplies, and demands for factors and commodities (including foreign trade for the latter); and macroeconomic data.

The primary data base for the model is the 2002 Social Accounting Matrix (SAM) for Uganda. Most of the model parameters are set endogenously in a manner that ensures the base solution to the model reproduces the values in the SAM (i.e. most of the model parameters are computed using data from the SAM). The remaining parameters, which include a set of elasticities, are set exogenously. The model explains how all payments or economic flows that are recorded in the SAM change as a result of an external shock (i.e., change in an exogenous variable or parameter). GAMS software is used to solve the model and to perform simulations. The disaggregated SAM and the GAMS code used for all simulations are provided in the appendix. To produce consistent results, a sensitivity analysis is performed using a new set of trade parameters (i.e. elasticities) and factor market closures. Sensitivity analysis pertaining to alternative parameters and closure rules is discussed in Chapter 7.

6.2 Production and Price Block

6.2.1 Choice of Production Technology

Each producer is represented by an activity and is assumed to maximize profits, defined as the difference between revenue earned and total costs (i.e. intermediate input costs, activity taxes and savings). Profits are maximised subject to a

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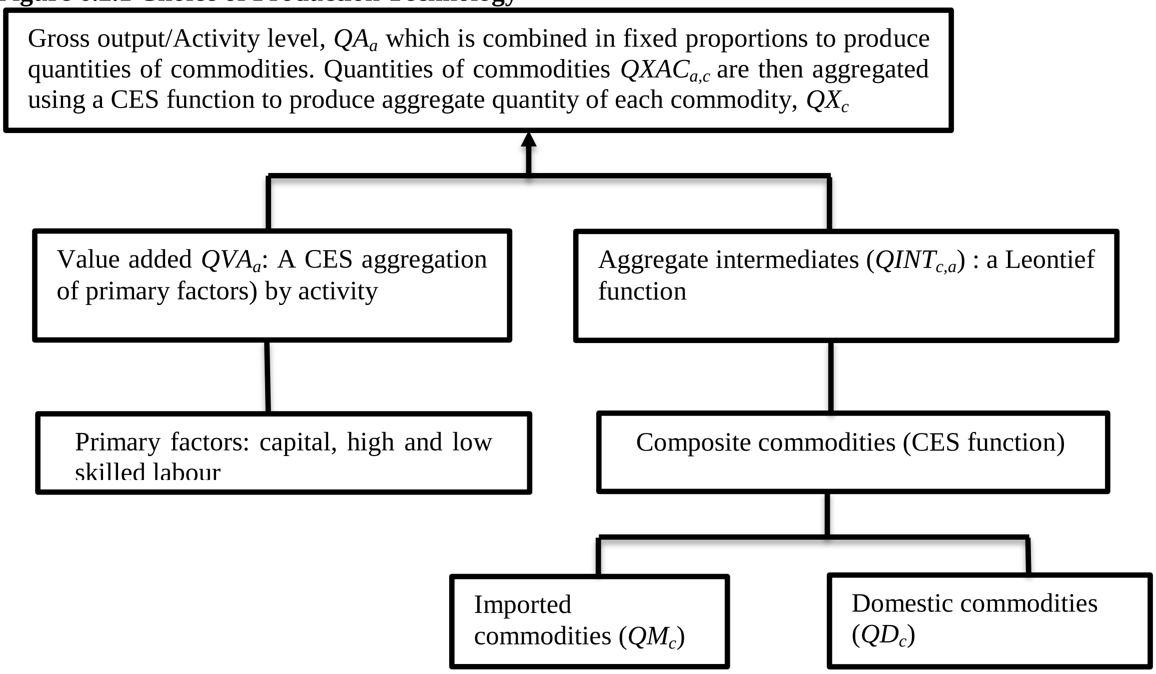
[22] Walras law states that the aggregate value of excess demands in the system equals the aggregate value of excess supplies. This implies that that an excess supply in any one market must be matched by an equal value of excess demand in some other market or markets (excess demand is zero).

production technology specified by a CES aggregation function of the quantities of value added and a Leontief aggregation of intermediate inputs. The production technology is a two-step nested structure (Figure 6.2.1). At the bottom level, primary inputs (i.e. labour and capital) are combined to produce value-added using a constant elasticity of substitution (CES) function. At the top level, aggregated value added (QVA_a) is then combined with aggregate intermediate input ($QINT_{c,a}$) within a fixed coefficient (Leontief) function to produce gross output (QA_a). Activity outputs are then combined in fixed proportions to produce quantities of commodities (equation 7). The quantity of commodity from each activity, $QXAC_{a,c}$ is then aggregated using a CES aggregation function to produce the aggregate quantity of domestic output of each commodity, QX_c (see equation 8 and figure 6.2.5). The profit maximization gives the demand for labour and capital.

Figure 6.2.1 Choice of Production Technology



Source: Adopted from Lofgren, Harris, and Robinson (2002) and modified by author.

6.2.2 Activity Value Added Function and Factor Demands

Each activity produces a final good whose value added QVA_a is obtained by means of a CES production function that captures the relationship between factor use and value added.

$$QVA_a = ava_a \left(\sum_{f \in F} \delta va_{f,a} QF_{f,a}^{-\rho va_a} \right)^{-\frac{1}{\rho va}} ; a \in A,\ \rho va = \frac{1}{\sigma va} - 1; \qquad (1)$$

where

ava_a = shift parameter in the CES activity production function,

$\delta va_{f,a}$ = CES value added function share parameter for factor *f* in activity *a*: $\sum_{f \in F} \delta va_{f,a} = 1$,

$QF_{f,a}$ = quantity demanded of factor *f* by activity *a*,

ρva_a = CES value added function exponent; $\rho va_a = \dfrac{1}{\sigma va_a} - 1$.

σva_a = elasticity of substitution for the value added production function.

6.2.3 Producer Demand for Factors of Production

The goal of each producer is to choose the input mix that minimizes the cost of production. This choice depends on the price of the inputs. The producer's minimization problem can be expressed by the Langragian function (*L*) below. Let

$$\left(L = \sum_{f=F} WF_f \ WFDIST_{f,a} \ QF_{f,a} + \lambda \left[\overline{Z} - PVA_a . ava_a \left(\sum_{f=F} \delta va_{f,a} QF_{f,a}^{-\rho va_a} \right)^{-\frac{1}{\rho va_a}} \right] \right)$$

(1.1)

where

$$\overline{Z} = PVA_a \ QVA_a \qquad (1.2)$$

WF_f = the average price (economy wide price/wage variable) of factor *f*,

$WFDIST_{f,a}$ = the price/wage distortion for factor *f* in activity *a*.

QVA_a = value added by activity ***a*.**

Wage distortion arises because of differences in education, training, gender and location etc. In such cases, factors that are mobile and are employed in different activities are paid an economy wide wage that is adjusted by the distortion term.

Each activity is assumed to pay an activity-specific wage that is the product of the economy wide wage and a wage distortion term. The first order conditions for profit maximization subject to the CES function gives the following demand equation for factor *f* in activity *a*:

$$WFDIST_{f,a} WF_f QF_{f,a} = \left(\frac{\delta va_{f,a} QF_{f,a}^{-\rho va_a}}{\sum_{f \in F} \delta va_{f,a} QF_{f,a}^{-\rho va_a}} \right) PVA_a QVA_a ; f \in F, a \in A \quad (2)$$

Equation (2) states that in a perfectly competitive market, producers demand factors up to the point where the price or marginal cost of each factor is equal the value of its marginal product/marginal revenue product. Given the values of other variables and parameters, the corresponding quantity of factor demanded by each activity ($QF_{f,a}$) can easily be determined. Note that if PVA_a is derived from the zero profit condition (i.e. equation 4.1) taking into account all components of gross output (i.e. value added, intermediate demand, production taxes and activity savings), then value added PVA_a QVA_a in equation (2) is expressed as $PVA_a QA_a$.

6.2.4 Activity Revenues and the Zero Profit Condition

Each activity saves (activity profits) and these savings are a proportion of the gross output of activity. Activity savings satisfy

$$QIA_a = ia_a QA_a \; ; a \in A \quad (3)$$

where

QIA_a = activity investment;

ia_a = quantity of investment per unit of activity *a;*

QA_a = activity level/gross output of activity *a*.

Activity revenue net of taxes is the sum of the total income allocated to aggregate activity production. In addition, for each activity, total revenues are equal to total expenditures. Expenditure is the sum of factor costs, material costs (intermediate demand), and activity profit (savings), and activity taxes. Each activity's revenue is the product of its activity price and quantity. The equality of revenues and expenditures generates the zero profit condition which satisfies

$$PA_aQA_a = \sum_{f\in F} WFDIST_{f,a} WF_f \ QF_{f,a} + \sum_{c\in C} PQ_c QINT_{c,a} + \\ PA_a QIA_a + ta_a PA_a QA_a \tag{3.1}$$

Equation (3.1) implies that

Gross activity revenue = cost of factors (value added) + cost of materials + activity profit (activity savings) + activity taxes.

Because of the definition of value added price (equation 3.2), factor input cost or value is given by

$$\sum_{f\in F} WFDIST_{f,a} WF_f QF_{f,a} = PVA_a QA_a \tag{3.2}$$

Alternatively, value added is computed from equation 3.1 as follows:

Value added = gross revenue-cost of materials-activity savings-activity taxes

$$\sum_{f\in F} WFDIST_{f,a} WF_f \ QF_{f,a} = PA_a QA_a - \begin{pmatrix} \sum_{c\in C} PQ_c QINT_{c,a} + \\ PA_a QIA_a + ta_a PA_a QA_a \end{pmatrix} \tag{3.3}$$

Material input costs (cost of intermediate inputs) satisfy

$$\sum_{c\in C} PQ_c QINT_{c,a} = \sum_{c} PQ_c ica_{c,a} QA_a \quad c\epsilon C; \tag{3.4}$$

Activity savings (profits) satisfies

$$PA_aQIA_a = ia_aPA_aQA_a \tag{3.5}$$

Activity tax is given by

$$ta_aPA_aQA_a \tag{3.5}$$

Rewriting equation (3.1), and dividing by QA_a, and collecting like terms, activity revenue net of taxes and savings is given by

$$(1 - ta_a - ia_a)PA_a = PVA_a + \sum_{c \in C} PQ_c \, ica_{c,a} \, ; a \in A \tag{4}$$

The corresponding aggregate price of value added, PVA_a can be computed when the values of parameters (i.e. ta_a, ia_a, and $ica_{c,a}$) and other variables are given. That is

$$PVA_a(1 - ta_a ia_a)PA_{a-} \sum_{c \in C} PQ_c \, ica_{c,a} \tag{4.1}$$

The quantity of commodity c as an intermediate input to activity a, $QINT_{c,a}$ is determined via a standard Leontief functional form and is given by the product of the intermediate input coefficient, $ica_{c,a}$ and gross activity output, QA_a. From equation (3.4), we obtain

$$QINT_{c,a} = ica_{c,a}QA_a ; \; a \in A, \; c \in C \tag{5}$$

Each activity price, PA_a is expressed in terms of the commodity yield and producer price of the commodity for each activity. The corresponding activity price equation is given by

$$PA_a = \sum_{c \in C} \theta_{a,c} PXAC_{a,c} \, ; \;\; a \in A; \, c \in C \tag{6}$$

$\theta_{a,c}$ = the yield of commodity c per unit of activity a,

$PXAC_{a,\,c}$ = producer price of commodity c for activity a.

The quantity of output of commodity c from activity a, $QXAC_{a,c}$ is the product of gross output/activity level and the yield coefficient of each commodity per unit of activity and this satisfies

$$QXAC_{a,c} = \theta_{a,c} QA_a \,; a \in A; c \in C \tag{7}$$

Thus, the commodity yield coefficient is given by

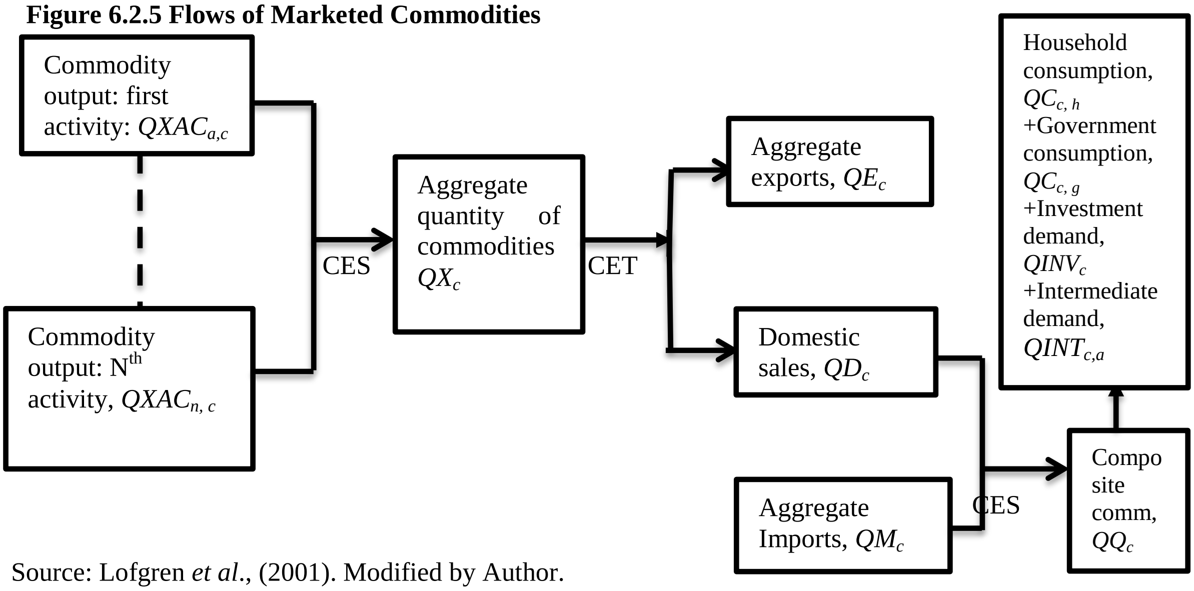
$$\theta_{a,c} = \frac{QXAC_{a,c}}{QA_a} \tag{7.1}$$

For all activities, the sum of all commodity yield coefficients satisfies $\sum_{a \in A} \theta_{a,c} = 1$.

6.2.5 Domestic Output Aggregation Function

The aggregate quantity of domestic output of commodity *c* (QX_c) may be consumed domestically (QD_c) or exported (QE_c). To generate aggregate domestic output (QX_c), the first stage consists of a CES aggregation of the quantity of commodity produced by each activity ($QXAC_{a,c}$). A constant elasticity of substitution (CES) function is used as the aggregation function based on the assumption of imperfect substitutability. Imperfect substitutability arises due to differences in location, quality, and timing between different producers of what is essentially the same commodity.

Figure 6.2.5 Flows of Marketed Commodities



Source: Lofgren *et al*., (2001). Modified by Author.

A CES aggregation function (Figure 6.2.5) is used to aggregate commodities produced by different activities, $QXAC_{a,c}$ into a single commodity or aggregate quantity of commodity (QX_c) which is then transformed using the CET for the domestic market (QD_c) or foreign market (QE_c). Domestic sales (QD_c) and imports (QM_c) are then combined via a CES aggregation function to generate a composite commodity (QQ_c)). The composite commodity is then made available for consumption by households ($QC_{c,h}$), government ($QC_{c,g}$), investment demand ($QINV_c$), and intermediate input demand ($QINT_{c,a}$). One of the macroeconomic constraints imposed in the model ensures that domestic supply equals domestic consumption (the sum of household and government consumption) plus investment demand and intermediate input demand.

The equilibrium condition of the producer involves minimising the cost of supplying a given commodity subject to the output aggregation function (equation 8). The inputs are given by $QXAC_{a,c}$ and are purchased at price $PXAC_{a,c}$. QX_c is the aggregate domestic output and is sold at price PX_c.

$$QX_c = aac_c \left(\sum_{a \in A} \delta ac_{a,c} QXAC_{a,c}^{-\rho ac_c} \right)^{-\frac{1}{\rho ac_c}} ; \; c \in C ; \; \rho ac_c = \frac{1}{\sigma ac_c} - 1 \quad (8)$$

$aac_c =$ shift parameter in the output aggregation function,

$\delta ac_{a,c} =$ share parameter for output aggregation function,

$\rho ac_c =$ domestic commodity aggregation function exponent,

QX_c = aggregate quantity of domestic output of commodity c,

$QXAC_{a,c} =$ quantity of output of commodity c from activity a.

Equation (8) can be expressed in nominal terms as $\overline{ZX} = PX_c QX_c$ so that QX_c appears as the output sold at the price, PX_c and produced with the inputs $QXAC_{a,c}$ which are purchased at the prices, $PXAC_{a,c}$. Equation (8) implies that demander preferences over outputs from different domestic producers are expressed as a CES function. The producer's problem is therefore to minimize the cost of inputs subject to the commodity aggregation function. The Langragian function of this problem is given by

$$\text{Min}\left[PXAC_{a,c}QXAC_{a,c} + \lambda[\overline{ZX_c} - PX_c.aac_c.\left(\sum_{a\in A}\delta ac_{a,c}.QXAC_{a,c}^{-\rho ac_c}\right)^{-\frac{1}{\rho ac_c}}\right] \quad (8.1)$$

where

$\overline{ZX_c}$ is fixed along the isoquant where cost minimization takes place. After rearranging, the first order condition generated by the output aggregation optimization problem above satisfies

$$PXAC_{a,c}QXAC_{a,c} = \left(\frac{\delta ac_{a,c}\,QXAC_{a,c}^{-\rho ac_c}}{\sum_{a\in A}\delta ac_{a,c}\,QXAC_{a,c}^{-\rho ac_c}}\right)PX_cQX_c \;;\; a\in A;\; c\in C \quad (9)$$

Under conditions of perfect competition, equation (9) states that the marginal cost of commodity *c* from activity *a* is equal to the marginal revenue product of commodity *c* from activity *a*. Put in a different way, each producer should hire an input up to the point where the value of the marginal revenue product is equal to the marginal cost.

From equation (9), the optimal quantity of the commodity from each activity ($QXAC_{a,c}$) is inversely related to the activity-specific price, $PXAC_{a,c}$. This suggests that a decline in the price ($PXAC_{a,c}$) charged by one producer relative to others would shift demand in his/her favour without totally eliminating demand for other high price sources. The degree of substitutability between different producers depends on the value of σac_c , the elasticity of substitution. Note that for a single producer of a given commodity, the value of the share parameter $\delta ac_{a,c}$ would be unity (Lofgren *et al*. 2001). This would imply $QXAC_{a,c} = QX_c$ and $PXAC_{a,c} = PX_c$

irrespective of the values of the elasticity of substitution and the CES function exponent.

6.2.6 Absorption, Export Prices, and Domestic-Export Output Ratio

The price system of the CGE model for Uganda assumes quality differences exist among exports, imports, and domestic output consumed domestically (Lofgren *et al*, 2002). In addition, endogenous prices are linked to other endogenous and exogenous prices, and to non-price model variables. The model adopts a downward-sloping, constant elasticity of transformation (CET) export demand curve. Uganda is modeled as a small country and can export any desired quantity at the prevailing world export prices. An export price, measured in local currency units is received by domestic producers whenever they sell their output in export markets. Export prices are net of the cost of trade inputs. The export price, PE_c of commodity c satisfies

$$PE_c = pwe_c\left(1 - te_c\right)EXR \tag{10}$$

$PE_c =$ price of exported commodity c in local currency units,

$pwe_c =$ free on board world export price of commodity c in foreign currency units,

$te_c =$ export tax rate/subsidy; $0 \le te_c \le 1$,

$EXR =$ exchange rate (local currency per unit of foreign currency).

When there is an exported version of the good, sales quantity QX_c is determined via a constant elasticity of transformation function (CET) given by

$$QX_c = ax_c\left(\delta x_c QE_c^{\rho x_c} + \left(1 - \delta x_c\right) QD_c^{\rho x_c}\right)^{\frac{1}{\rho x_c}};\, c \in CE,\ \rho x_c = \frac{1}{\sigma x_c} + 1 \tag{11}$$

For non-exported commodities, equation 11 satisfy

$$QX_c = QD_c;\, c \in CNE \tag{12}$$

Absorption requires that the total domestic supply of each commodity should be equal to total foreign and domestic demand (Figure 6.1.2). Given the CES transformation of domestic and foreign goods produced domestically, and their corresponding expenditures, the optimal combination is given by the first order condition of the Langragian function below.

$Max\ \left(PX_c\, QX_c = PD_c\, QD_c + PE_c\, QE_c\right)$ Subject to:

$$QX_c = ax_c.\left(\delta x_c\, QE_c^{\rho x_c} + \left(1-\delta x_c\right)QD_c^{\rho x_c}\right)^{\frac{1}{\rho x_c}} \tag{12.1}$$

The optimal combination from the above satisfies

$$\frac{QE_c}{QD_c} = \left(\frac{1-\delta x_c}{\delta x_c}\cdot\frac{PE_c}{PD_c}\right)^{\sigma x_c};\ c \in CE\ ;\ \sigma x_c = \frac{1}{\rho x_c - 1} \tag{13}$$

The corresponding expenditures are given by

$$PX_c QX_c = PD_c QD_c + PE_c QE_c\ ; c \in CE \tag{14}$$

In case of non-exported goods, the corresponding expenditures satisfy

$$PX_c QX_c = PD_c QD_c\ ;\ c \in CNE \tag{15}$$

Using equations 14 and 15, the aggregate producer price for commodity c, PX_c can be computed for any exported and non-exported commodity, c.

6.2.7 Import Prices and the Domestic-Import Output Ratio

The price of imports PM_c is inclusive of any tariffs that might be imposed on foreign commodities entering the domestic market. Under the small country assumption, Uganda is able to import any quantity at the fixed international import prices (i.e., Uganda is price taker). In addition, the model adopts the commonly used Armington assumption with regard to imports. The rest of the world price for Uganda's imports, pwm_c (expressed in foreign currency units) is adjusted into local currency units (PM_c) by means of the exchange rate (EXR). The price of imports measured in local currency units is given by

$$PM_c = pwm_c\left(1+tm_c\right)EXR \;;\; c\in CM \tag{16}$$

$PM_c =$ price of imported commodity c in local currency units,

$pwm_c =$ free on board world import price in foreign currency units,

$tm_c =$ import tax rate/subsidy; $0 \le tm_c \le 1$,

$EXR =$ exchange rate (local currency unit per unit of foreign currency).

To distinguish between domestically produced goods and an imported version of the same good produced domestically, each composite commodity is defined by a CES aggregation (Armington function) given by

$$QQ_c = aq_c\left(\delta q_c QM_c^{-\rho q_c} + \left(1-\delta q_c\right)QD_c^{-\rho q_c}\right);\; c\in CM \;;\; \rho q_c = \frac{1}{\sigma q_c} - 1 \quad 17)$$

For a non-imported version of the commodity, equation (17) satisfies

$$QQ_c = QD_c \;;\; c \in CNM \tag{18}$$

Given the specific prices for domestic and imported goods and their corresponding expenditures, the problem facing the user or buyer is the minimization of the cost of obtaining the aggregate composite good subject to the CES function. The Langragian is given by

$Min \;\; QQ_c = \left(PD_c \;\; QD_c + PM_c \;\; QM_c\right)$ subject to

$$QQ_c = aq_c\left(\delta q_c QM_c^{-\rho q_c} + \left(1-\delta q_c\right)QD_c^{-\rho q_c}\right) \tag{18.1}$$

The Langragian function from the above yields t6he optimal combination given by

$$\frac{QM_c}{QD_c} = \left(\frac{PD_c}{PM_c}.\frac{\delta q_c}{1-\delta q_c}\right)^{\sigma q_c} \;; c\in CM \;;\; \sigma q_c = \frac{1}{1+\rho q_c} > 0 \tag{19}$$

Equation (19) states that the import-domestic output ratio depends on relative prices and is inversely related to the relative price ratio. An increase in the import-domestic output ratio leads to a shift of consumers away from the expensive domestic good to the relatively cheaper version of the imported good and vise-versa.

The choice between the import version of the good and the domestic good depends on the value of the elasticity of substitution, σq_c. The corresponding expenditures on imports and domestic goods net of taxes is given by

$$(1-tq_c)PQ_c\,QQ_c = PD_c QD_c + PM_c QM_c;\ c \in CM \tag{20}$$

For a set of non-imported commodities with domestic production, equation 20 satisfies

$$(1-tq_c)PQ_c\,QQ_c = PD_c QD_c;\ c \in CNM \tag{21}$$

6.3 Factor Incomes and Institutional Incomes from Factors

6.3.1 Total Factor Incomes

The total gross income of each factor (i.e., labour and capital), YF_f is given by the sum of activity payments to the factor. The 2002 SAM for Uganda does not have factor taxes (i.e. factor incomes are gross incomes). The equation for factor incomes satisfies

$$YF_f = \sum_{a \in A} WF_f\ WFDIST_{f,a}\ QF_{f,a};\ f \in F \tag{22}$$

where

YF_f = gross income of factor *f*,

$WFDIST_{f,a}$ = wage distortion factor for factor *f* in activity a,

$QF_{f,a}$ = quantity demanded of factor f in activity a.

6.3.2 Income of Domestic Institutions from Factors

Gross factor income, YF_f is netted of transfer payments to the rest of the world and paid in shares among all domestic institutions. The income of each institution from factor *f* satisfies

$$YIF_{i,f} = shinc_{i,f}\left(YF_f - YIF_{r,f}\right);\ i \in ID;\ f \in F \tag{23}$$

where

$YIF_{i,f}$ = income to domestic institution *i* from factor *f*,

$shinc_{i,f}$ = share for institution *i* in the income of factor *f*,

YF_f = income of factor *f*,

$YIF_{r,f}$ = income to the rest of the world from factor *f* (an exogenous variable).

To ensure that all the total factor income is distributed, the sum of the shares for all domestic institutions must sum up to unity. That is, $\sum_{i \in ID} shinc_{i,f} = 1$.

6.3.3 Income of Domestic Non-government Institutions

Non-governmental institutions comprise of households and enterprises. The total income of any domestic non-government institution i, Y_i include its share of factor incomes, transfers that it receives from other domestic non-government institutions, transfers from the government, and the rest of the world. Transfers from the rest of the world are indexed to the exchange rate since they are fixed in foreign currency units. In addition, government transfers are indexed to the *CPI* to account for changes in prices (inflation). Total institutional income received by domestic non-government institution *i* is given by

$$Y_i = \sum_{f \in F} YIF_{i,f} + \sum_{i' \in IDNG} TR_{i,i'} + TR_{i,g} CPI + TR_{i,r} EXR \;; i \in IDNG \tag{24\_1}$$

6.3.4 Government Income

According to the SAM, government income is comprised of import and export taxes, sales tax (VAT), and activity taxes, direct taxes from households and enterprise, and transfers from the rest of the world.

$$\begin{aligned} Y_g = & \sum_{f \in F} YIF_{g,f} + \sum_{i \in IDNG} ty_i Y_i + TR_{g,r} EXR + \sum_{c \in C} tq_c \left(PD_c QD_c + PM_c QM_c \right) + \\ & \sum_{a \in A} ta_a PA_a QA_a + \sum_{c \in CM} tm_c EXR \; pwm_c QM_c \end{aligned} \tag{24\_2}$$

Y_g = government revenue,

$YIF_{g,f}$ = income of government from factor *f*,

ty_i = direct tax rate for institution i,

Y_i = income of institution *i*,

$TR_{g,r}$ = transfers from rest of the world to government,

EXR = the exchange rate (foreign currency per unit domestic currency),

tq_c = rate of sales tax,

PD_c = supply price for commodity c produced and sold domestically,

QD_c = quantity sold domestically of domestic output.

6.4 Institutional Expenditures

6.4.1 Expenditure by Domestic Non-governmental Institutions

Domestic non-governmental institutions use all or part of their disposable income to demand commodities, pay taxes to the government, make transfers to other institutions and to save. Savings by domestic institutions, $DSAV_i$ are defined explicitly to make the model more sensible. What remains from their disposable income after direct taxes, savings, and transfer payments have been deducted is the total value of their consumption expenditure, $EXPE_i$. This expenditure satisfies

$$DSAV_i + EXPE_i + \sum_{i' \in IDNG} TR_{i',i} + TR_{r,i} = \left(1 - ty_i\right) Y_i\, ; \; i' \notin i \in IDNG \quad (25\_1)$$

$DSAV_i$ = savings by domestic non-government institution *i*,

$TR_{i,i}$ = transfer of income from domestic non-government institution *i* to other domestic non-governmental institutions, *i'*,

ty_i = direct tax rate of domestic non-government institution *i*,

Y_i = income of domestic non-governmental institution *i*,

$TR_{r,i}$ = transfer from domestic non-government institution *i* to the rest of the world.

6.4.2. Government Expenditure and Budget Constraint

Total government expenditure, $EXPE_g$ is comprised of total government consumption of commodities, transfers to domestic non-governmental institutions and to the rest of the world, and export taxes/subsidies. Government transfers to the rest of the world are indexed to the exchange rate so that the corresponding value in the SAM is valued in local currency units. The equation for government expenditures satisfies

$$EXPE_g = \sum_{c \in C} PQ_c QC_{c,g} + \sum_{i \in IDNG} TR_{i,g} CPI + \frac{TR_{i,g}}{EXR} + pwe_{c \in CE} EXRQE_{c \in CE} \qquad (25\_2)$$

where

$EXPE_g$ = expenditure by government,

PQ_c = composite commodity price paid by domestic demanders,

$QC_{c,g}$ = quantity consumed of commodity c by government,

$TR_{i,g}$ = government transfers to domestic non-government institution i,

CPI = the consumer price index,

$TR_{r,g}$ = government transfers to the rest of the world,

EXR = is the exchange rate (local currency per unit foreign currency),

te_c = export tax/subsidy on commodity c,

pwe_c = world export price of commodity c,

QE_c = quantity of export of commodity c.

6.4.3 Government Budget Constraint *(GBS)*

Government saving $DSAV_g$ is defined as the difference between government income, Y_g and government expenditure, $EXPE_g$ (excluding government investment spending). The equation for government budget surplus satisfies

$$DSAV_g + EXPE_g = Y_g \qquad (25\_3)$$

Note that government expenditure can be held fixed through the adjustment variable, *GADJ*. Holding government expenditure constant in simulations helps to isolate the effects of exogenous changes and policies that are being analysed (Dorosh *et al*., 2002).

6.4.4 Marginal Propensity to Save for Domestic Non-governmental Institutions

The marginal propensity to save for households and enterprise is defined as a parameter, equal to its initial value and is made endogenous via the savings adjustment variables, *HSADJ* and *ESADJ* (for households and enterprise separately). In conducting simulations, only one of these parameters is made exogenous if investment is endogenous via the investment adjustment variable, *IADJ*. The savings adjustment function for households satisfies

$$\left(1 + hsdum_i . HSADJ\right) * mps_i = \frac{DSAV_i}{\left(1 - ty_i\right)Y_i};\ i \in H \qquad (26\_1)$$

where

$hsdum_i$ = household saving dummy; zero when savings is exogenous, and 1 when savings is endogenous,

HSADJ = household saving adjustment variable; equals zero when saving is endogenous, 1 when saving is exogenous)

$DSAV_i$ = savings of domestic non-governmental institution i,

ty_i = direct tax rate of domestic non-governmental institution i,

mps_i = initial vale of the marginal propensity to consume for domestic non-governmental institution i,

Y_i = Income of domestic non-government institution i.

The corresponding equation for the enterprise is given by

$$\left(1 + ESADJ\right) * mps_E = \frac{DSAV_E}{\left(1 - ty_E\right)Y_E} \qquad (26\_2)$$

where

ESADJ is the enterprise/firm saving adjustment variable; equals zero when saving is endogenous, 1 when saving is exogenous. According to the SAM, only households save and only their savings are allowed to adjust to finance investment in simulations with the investment driven savings closure.

6.5 Institutional Expenditure on Marketed Commodities

It is assumed that each domestic non-governmental institution maximizes a Cobb-Douglas utility function subject to its budget constraint. The Cobb Douglas utility function has been widely used in studies with the CGE modeling framework mainly because it is simple, tractable, and has the ability to generate empirical results that can be tested (Pauw, 2004; Heffetz, 2007). In addition, the utility function is preferred in this dissertation because the construction of the Linear Expenditure System (LES) requires the estimation of the parameter that measures the minimum subsistence requirement imposed on each commodity, of which data is not readily available. In our analysis, we assume a subsistence level of zero and assume a simple Cobb-Douglas function. This function assumes unitary elasticity and constant average and marginal propensity to consume when deriving household preferences. The total utility function of household h from commodity c is given by

$$UH_h = \prod_{c \in C} \left(\frac{QC_{c,h}}{\beta_{c,h}} \right)^{\beta_{c,h}} \tag{26.3}$$

$\beta_{c,h}$ = the marginal share of consumption spending for household h on marketed commodity c (a Cobb-Douglas parameter),

$QC_{c,h}$ = quantity of marketed commodity c consumed by household h.

The utility maximization problem of domestic non-government institution i under the assumption of constant average and marginal propensity to consume is given by

$$Max\ UH_h = \sum_{c \in C} \beta_{c,h}\ ln\left(QC_{c,h}\right);\ \sum_{c \in C} \beta_{c,h} = 1 \tag{26.4}$$

subject to the budget constraint which satisfies

$$EXPE_h = \sum_{c \in C} PQ_c QC_{c,h} \tag{26.5}$$

The Lagrangian for this optimization problem is therefore given by

$$Max\ \ L = \prod_{c \in C} \left(\frac{QC_{c,\ h}}{\beta_{c,\ h}} \right)^{\beta_{c,\ h}} + \lambda \left(EXPE_h - \sum_{c \in C} PQ_c QC_{c,h} \right) \tag{26.6}$$

The demand function of institution i for commodity c can be generated by differentiating equation (26.6) with respect to $QC_{c,\ i}$ and rearranging the first order condition. The resulting demand function satisfies

$$PQ_c\ QC_{c,h} = \beta_{c,h}\ EXPE\ _h\ ;\ \sum_{c \in C} \beta_{c,h} = 1 \tag{27}$$

The marginal share of consumption spending for each household on commodity c can be computed as follows

$$\beta_{c,h} = \frac{PQ_c QC_{c,h}}{EXPE_h}; \quad c \in C \tag{27.1}$$

Note that the marginal share of consumption spending on commodity c by each household is a proportion of the total expenditure by that household.

6.5.1 Household Utility and the Consumer Price Index

Let *UH*, *EXP*, and *CPI* represent the aggregate indirect utility, household expenditure, and consumer price index for the economy. By definition, total expenditure of all households, $EXPE = \sum_h EXPE_h$ and $UH = \sum_h UH_h^{\omega_h}$ where ω_h is the weight given to household group *h* (in our numerical analysis we shall let $\omega_h = 1$ for all *h*). We also know that *UH*, *EXP*, and *CPI* should satisfy *EXPE = UH*CPI* . Hence,

$$EXPE = \sum_h EXPE_h = \sum_h CPI_h UH_h \tag{27.2}$$

This further implies,

$$CPI = \sum_h CPI_h \left(\frac{UH_h}{UH} \right) \qquad (27.3)$$

6.6 Government and Investment Demand for Commodities

6.6.1 Government Consumption Demand

Government consumption demand of commodity, $QG_{c,g}$ is a proportion of the base year quantity of government demand of commodity c, qg_c. According to the 2002 Uganda SAM, government consumption expenditure comprises of three commodities namely transport, construction, and other service commodities. Expenditures on services were recorded as consumption spending in the core government account. Government consumption demand satisfies

$$QC_{c,g} = qg_c \, GADJ \;\; ; \; c \in C \qquad (28)$$

where

$GADJ$ = a variable representing government consumption adjustment factor,

qg_c = base year quantity of government consumption demand for commodity c.

6.6.2 Investment Demand for Commodities

The quantity of fixed investment demand for commodity c, $QINV_c$ is defined as the product of base year quantity, $qinvi_c$ and an adjustment factor, $IADJ$. Thus, investment expenditure on commodity c is given by

$$QINV_c = qinvi_c IADJ ; \; c \in C \qquad (29)$$

where

$qinvi_c$ = base year quantity of private investment demand for commodity c,

$IADJ$ = investment adjustment factor.

6.7 Equilibrium in Foreign, Commodity, and Factor Markets

6.7.1 Market Equilibrium Condition for the Composite Commodity

The model assumes that each commodity market is in equilibrium. For each commodity c, the composite supply should be equal to demand for intermediate inputs, domestic demand by institutions, and investment demand according to the following equation.

$$QQ_c = \sum_{a \in A} QINT_{c,a} + \sum_{i \in ID} QC_{c,i} + QINV_c \,; c \in C \tag{30}$$

where

QQ_c = quantity of composite commodity c supplied to domestic market,

$QINT_{c,a}$ = intermediate demand for commodity c from activity a,

$QC_{c,i}$ = quantity consumed of commodity c by domestic non-governmental institution *i*.

$QINV_c$ = quantity of investment demand for commodity c.

6.7.2 Factor Market Equilibrium

Equilibrium in the factor market requires that each activity demand for the factor be equal to supply of the factor. This satisfies

$$\sum_{a \in A} QF_{f,a} + QFU_f = QFS_f \,;\; f \in F \tag{31}$$

where

$QF_{f,a}$ = quantity demanded of factor f from activity a,

QFU_f = quantity unemployed of factor f,

QFS_f = quantity supplied of factor f.

6.7.3 Market Equilibrium Condition for the Current Account

We adopt a flexible real exchange rate and fixed foreign savings as closure in all simulations (Dorosh and Thurlow, 2009; Mbabazi, 2009). The exchange rate is allowed to vary to clear any excess demand or supply of foreign currency. Under this closure, Uganda cannot increase its foreign debt to pay for new investments and that the country has to generate export earnings to finance imported goods and services. In fact, a flexible real exchange rate permits Uganda's economy to adjust to external shocks e.g. terms of trade shocks (Poverty Reduction Strategy Paper, 2010). On the other hand, a flexible exchange rate regime gives authority to officials at Bank of Uganda (i.e. the central bank) the flexibility they need to intervene in the exchange rate market. If the exchange rate depreciates and terms of trade deteriorate, the monetary authorities could increase the stock of the country's foreign exchange reserves. This argument is further advocated for developing economies, Uganda inclusive, with undeveloped capital and financial markets and significant differences in their composition of exports and imports. In addition, it has also been suggested that economies that maintain flexible exchange rates tend to experience lower GDP volatility when faced with external shocks (Broda, 2004; and Friedman, 1953). Even though the assumption of flexible exchange rate limits the degree of import competition in the domestic market, it highlights the desire of Uganda's economy to pursue an export led growth strategy through the promotion of industrial and agricultural export sectors. The equilibrium condition for the external sector satisfies

$$\begin{aligned} &\sum_{c \in C} pwm_c QM_c + \sum_{i \in ID} TR_{r,i} / EXR + \sum_{f \in F} YIF_{r,f} / EXR \\ &= \sum_{c \in C} pwe_c QE_c + \sum_{i \in ID} TR_{i,r} + FSAV \end{aligned} \tag{32}$$

A fixed real exchange rate regime may also be assumed in which the *EXR* is set exogenously to a desired level and the foreign savings is allowed to vary to clear the deficit on the current account. With this closure, the government can increase its foreign debt to pay for new investments (i.e. increase in imports). The increase in imports (i.e. capital imports) may boost investment in local sectors which could consequently create a positive impact on aggregate output and employment.

6.7.4 Global Equilibrium

The global equilibrium in the economy is satisfied when the difference between the value of savings by all institutions and investment expenditure on all commodities is zero. A *WALR* value of zero ensures consistency of simulations. The *WALR* is given by

$$WALR = \sum_{i \in ID} DSAV_i + \sum_{a \in A} PA_a QIA_a + FSAV.EXR - \sum_{c \in C} PQ_c QINV_c \qquad (33)$$

where

$DSAV_i$ = savings of domestic institution i,

QIA_a = is activity profits/savings,

$FSAV$ = foreign savings,

EXR = is the exchange rate,

$QINV_c$ = Investment demand for commodities,

PQ_c = composite price paid by domestic demanders for commodity c,

PA_a = activity price.

In order to close the savings-investment gap[23] (i.e. the difference between national and foreign savings, and investment), the model adopts the investment is savings driven closure rule (investment is fixed). Foreign savings, *FSAV* is fixed under the exchange rate closure; this leaves only total domestic savings ($DSAV_g + DSAV_h$) as the only variables to adjust to close the gap. Accordingly, the savings of domestic institutions adjust to close the savings-investment gap.

[23] $PQ_cQINV_c = DSAV_{IDNG} + DSAV_G + FSAV$

6.7.5 Price Normalization as a Closure Rule

The price normalization rule states that the *CPI* is the sum across all commodities of the product of commodity weights and the composite price paid by domestic demanders.

$$CPI = \sum_{c \in C} cwts_c PQ_c; \ \ c \in C \tag{34}$$

where

$CPI =$ consumer price index,

$cwts_c =$ weight of commodity c in the *CPI;* $\sum_{c \in C} cwts_c = 1$,

$PQ_c =$ composite commodity price paid by domestic demanders.

The model presented up to this point is homogeneous of degree zero in prices. This implies that if one equilibrium solution exists, there are an infinite number of solutions (each of which has the same relative prices). In order for only one solution to exist, the above price normalization equation which fixes a measure of the consumer price index (*CPI*) has been added. Given the definition of the price normalization equation, all simulated price changes can be directly interpreted as changes vis-à-vis the *CPI.* There is no money in the model (i.e. the model produces relative prices and real variables).

6.8 Intra-Institutional Transfers

6.8.1 Transfers between Domestic Non-Governmental Institutions

Transfers between domestic non-government institutions are paid as a share of the difference between income after taxes and domestic savings. The equation for intra-institutional transfers satisfies

$$TR_{i,i'} = shtr_{i,i'}(1 - ty_{i'})Y_{i'} - DSAV_{i'}) \ ; i' \notin i \in IDNG \tag{35}$$

$TR_{i,i'}$ = transfer from institution *i'* to institution *i* ,

$shtr_{i,i'}$ = the share of income of domestic non-government institution *i'* in transfers to institution *i*. Note that $shtr_{i,i'} = 0 \; ; \; i = i' \in H$

ty_i = direct tax rate for domestic non-government institution *i*,

$DSAV_i$ = domestic savings by non-government institution *i*.

Only non-zero transfers are endogenised in our model (i.e. for those domestic non-governmental institutions whose equations are defined). Similarly, transfers from domestic non-government institutions to government are endogenised as taxes while those transfers from government to non-government institutions and from the rest of the world to domestic institutions, and from domestic institutions to the rest of the world are exogenised (Appendix A5). The purpose of exogenising some transfers is to enable us conduct simulations. For example, given the importance of workers remittances to Uganda's economy in general and to household welfare in particular (see Chapter 2 and Chapter 7), this dissertation seeks to analyse the impact of a 50 percent increase in the base value of workers remittances. These transfers are from the rest of the world and are received by Ugandan households (i.e. $TR_{h,r}$). To perform the simulation involving remittances, we generate a parameter that is equal to an increase in migrant workers remittances by 50 percent (*REMIT_INCR*).

6.9 Choice of Closure Rules and their Policy Implications

6.9.1 Macro Closures

Computable General equilibrium (CGE) models have more variables than equations. Solving such models mathematically necessitates making a choice about endogenous and exogenous variables. The choice between these variables is constrained by the fact that the number of endogenous variables and equations in the model should be equal. Economically speaking, the term closure means making sure that the number of exogenous variables are selected in such a way that the economic situation in which the policy shock is tested best reflects the true economic environment in which the policy shock is examined. In addition, the choice of a particular closure is governed by two factors: First, the time frame under which economic variables are allowed to adjust to a new equilibrium (i.e. short-run vs. long-run equilibrium analysis), and second, the particular hypothesis to be tested within the simulation and the viewpoint of the modeler on those variables that are exogenous to the model.

The choice of macroeconomic closures used in CGE models have been widely debated (Robinson, 1989; Rattsø, 1982; and Taylor, 1990). The model adopted in this dissertation makes a number of assumptions on how Uganda's economy maintains macroeconomic equilibrium. In most static CGE models, The Johansen closure rule (i.e. fixed foreign savings, and fixed investment and government consumption expenditure) is adopted so that the welfare changes generated by simulations are not misleading (Nganou, 2005). The CGE model for Uganda is static, and therefore uses the Johansen closure to avoid misleading welfare effects.

6.9.2 Factor Market Closure Rules

We adopt three closure rules that relate to factor markets in Uganda. First, we assume that high skilled labour and capital are fully employed. This implies that factor wage WF_f for high skilled labour and capital adjusts to clear the labour and capital market. Each activity *a* is free to employ high skilled labour and capital, $QF_{f,a}$ at the ongoing factor wage W_f. In addition, the wage distortion term for high skilled labour and capital for each activity *a*, $WFDIST_{f,a}$ is endogenous i.e. allowed to vary. The use of the full employment closure rule is due to the acute shortage of skills common in most developing countries, Uganda inclusive.

The second closure rule (unemployment closure) assumes that low skilled labour is unemployed. Under this closure rule, the real wage rate is fixed and the quantity of unemployed low skilled labour adjusts to clear the labour market. In addition, the wage distortion term for low skilled labour is fixed. The choice of the unemployment closure rule is due to the fact that Uganda like any developing country has notable labour surplus (i.e. unemployment).

As for capital, we also assume a segmented factor market and each activity employs an observed, base year quantity of capital (i.e. capital is fully employed and activity specific. This segmentation is suitable for short-run analysis and where there are significant quality differences between different units of capital i.e. capital used in industries and service activities (Lofgren *et al*. 2002). The price distortion factor for activity specific capital, $WFDIST_{k,a}$ adjusts to equilibrate the capital market. The quantity of activity-specific capital $QF_{k,a}$ and the activity specific wage $WF_{k,a}$ are fixed. The summary of closure rules used in this dissertation is presented in Table 6.9.2.

Table 6.9.2 Closures Rules and Simulations for the CGE Model

	Closure Rule
Low skilled labour	*LABCLOS3*
High skilled labour	*LABCLOS1*
Capital	*CAPCLOS1*
Saving- investment	*SICLOS1*
Current Account	*EXRCLOS1*
Numeraire Price	*Fixed CPI*

Source: Lofgren *et al*., (2002). Note: *LABCLOS1*: Labour is assumed to be fully employed and mobile. *LABCLOS3*: Factor is assumed to be unemployed and mobile. *CAPCLOS1*: Capital is assumed to be fully employed. *SICLOS1*: is the saving is investment driven closure (Investment is fixed, allowing savings of selected institutions to adjust to finance investment); *EXRCLOS1*: Foreign savings is fixed, exchange rate is flexible; CPI: Consumer Price Index.

6.10 Verification of the Model's Algebraic Consistency

We match the number of independent equations with the number of variables. To do this, we fix the number of elements of the sets that represent activities (*a*), commodities (*C*), exported commodities (*CE*), non-exported commodities (*CNE*), imported commodities (*CM*), and non-imported commodities (*CNM*), factors of production (*F*), and institutions, *I* which include domestic institutions, *ID* and the rest of world, *R*. From the disaggregated SAM and Table A1 (see appendix), we have

A=C=10; CM=6; CNM=4; CE=8; CNE=2; f=9; I=11; ID=10; R=1.

From the list of variables in Table A4 (appendix), we have 1012 endogenous variables. Of these, 172 are exogenous variables: Transfers from the government and the rest of the world to domestic non-governmental institutions, ($TR_{IDNG\ ,g}$) and ($TR_{IDNG,\ r}$); income for the rest of the world (Y_R); income to the rest of the world from factor *f* ($YIF_{f,,r}$); quantity consumed of commodity c by the rest of the world ($QC_{c,r}$) and enterprise ($QC_{c,e}$); Government adjustment factor (*GADJ*); household saving adjustment variable (*HSADJ*); exchange rate (*EXR*); expenditure by the enterprise/firm ($EXPE_E$); The consumer price index (*CPI*); quantity supplied of factor *f* (QSF_f); quantity unemployed of factor *f* (QFU_f); and all the price distortion terms for all factors in each activity, *a* ($WFDIST_{f,a}$). This leaves 840 variables to be determined. As for the number of equations, we have 840 independent equations to be determined. Thus, the number of equations and variables is identical, making the model consistent. After making adjustments with regard to those equations and variables for which SAM values are zero, we have 776 equations and variables (see appendix A5). The basic model is solved using GAMS software. The GAMS code used to perform the simulations is provided in appendix B.

6.11 Parameters for Calibrating the CGE Model for Uganda

The development and use of a computable general equilibrium (CGE) model depends on the social accounting matrix (SAM) of an economy being studied. The SAM describes the initial state of the economy (Decaluwe *et al*. 2006). CGE models are characterised by production and consumption functions that require the use of parameter values that generates initial values of the SAM. The process of generating these parameters is referred to as calibration. In most cases, the SAM does not provide adequate information for calibrating all the parameters. The use of the constant elasticity of substitution (CES), constant elasticity of transformation (CET) functions and the linear expenditure system (LES) requires that income, price, or own elasticities of substitution be estimated for calibrating the CGE model (Annabi *et al*. 2006). In cases where these parameters cannot be estimated, use is made of those estimates for economies that share similar social and economic characteristics. Other studies have suggested that the choice and borrowing of existing parameter estimates to calibrate CGE models need to be done cautiously. The use of such parameters might generate effects of policy shocks that are not consistent with the economy under study (Arndt, Robinson, and Tarp, 2000; and McKitrick, 1998). To overcome this problem, studies have recommended that sensitivity analyses be performed under varying trade parameters and alternate factor and macro closures (Nganou 2005; Pagan and Shannon, 1985; and Harrison and Vinod, 1992). Note that results of the sensitivity analysis regarding all simulations are presented in Chapter 7.

In Uganda, like many developing economies, there is lack of adequate and reliable data that is required to estimate parameters to calibrate the CGE model. Therefore, most studies borrow parameters from regions perceived to have with identical socioeconomic conditions with the economy being modelled. In Uganda, a number of studies have applied the CGE modelling framework to analyse the effects of exogenous changes and policies with parameters borrowed elsewhere (Thurlow, 2008; Dorosh and Thurlow, 2009; Dorosh *et al*., 2002; Boysen *et al*., 2008; Lindsay *et al*., 2008; Matovu *et al*., 2009; Mbabazi *et al*., 2002; and Lofgren *et al*., 2002).

In selecting parameters for calibrating the CGE model for Uganda, reference is made to the above studies and where necessary, similarities in outcomes of exogenous changes and policies have been mentioned (Chapter 9) to ensure consistency of model outcomes. For most of the goods in the model for Uganda, a medium to high elasticity of two in forming the composite good implies a modest substitutability between the imported and domestically produced input (Mbabazi, 2002). Generally, most of the selected elasticities have been used in the extended dynamic computable equilibrium model for Uganda and South Africa (Thurlow *et al.*, 2008). Apart from these elasticities, most of the parameters and coefficients of the CGE model for Uganda are calibrated from the base data of the 2002 SAM. Since the choice of elasticities used in production and consumption functions may influence the results of our simulations, we perform a sensitivity analysis using alternative trade parameters to check the robustness of the model (Chapter 7). A summary of trade parameters is provided in Tables 6.11.1 and 6.11.2 below.

Table 6.11.1 Parameters in the CGE Model for Uganda

Commodity	Armington function	CET function (export)	Value added CES
Agriculture	2.5	2.5	2
Mining and Quarrying	0.9	0.9	2
Food Processing	2	2	2
Manufacturing	3.8	3.8	2
Electricity and Water	2.8	2.8	2
Construction	1.9	1.9	2
Trade Services	1.9	1.9	2
Transport and Communication	1.9	1.9	2
Health and Education	1.9	1.9	2
Other Service	1.9	1.9	2

Source: Thurlow, J. (2008). IFPRI CGE Model for Uganda.

Table 6.11.2 Other Elasticities of Substitution and Transformation

Commodity	Armington function	CET function (export)
Agriculture	3	3
Mining and Quarrying	-	1.5
Food Processing	2.5	1.5
Manufacturing	2.5	1.5
Electricity and Water	2.5	1.5
Construction	-	1.5
Trade Services	-	1.5
Transport and Communication	2.5	1.5
Health and Education	2.5	1.5
Other Service	2.5	1.5

Source: Dorosh, El-Said, and Lofgren, 2002.

6.12 Conclusion

The objective of this chapter was to explain and present a detailed analysis of the features of the CGE model for Uganda. As mentioned earlier, this model is follows adopts the core features of the standard CGE model developed by IFPRI

(Lofgren *et al*. 2001). A number of first order optimization conditions were explained. In order to link macroeconomic constraints to the CGE model and analyze the impact of exogenous changes on factor and household incomes, we adopted a set of closure rules that are closely linked to the features of Uganda's factor and foreign markets. In addition, the choice and source of parameters for calibrating the CGE model for Uganda is discussed. In the next chapter, we present the micro and macroeconomic impact of simulations.

Chapter 7

Simulations in the CGE Model for Uganda

7.1 Introduction

The CGE model for Uganda is solved as mixed complementarity problem using the General Algebraic Modelling System (GAMS). The MCP formulation is useful for expressing systems of non-linear inequalities and equations; the complementarity allows boundary conditions to be specified in a succinct manner (Dirkse, 1994). Once the model solves normally and returns the initial base year solution values in the SAM (i.e. factor prices, sectoral outputs, output prices, and institutional incomes), the economy wide effects arising from exogenous changes in tariff rates, migrant remittances, export prices, and foreign savings are analysed by shocking relevant policy variables through a series of simulations. Using these exogenous changes, the model is solved again for a new set of solutions. The resulting set of solution variables is compared with the base solution. For simplicity, the effects of all simulations on selected variables are presented as percentage changes from their respective pre-shock values and the causes of these changes are explained.

This chapter is intended to explain the design of simulations relevant to the research questions this dissertation seeks to address, that is which sectors and agents are mostly affected by exogenous changes and what are their growth and welfare implications to Uganda's economy? In the next section, we give a detailed explanation of the design of selected policy shocks to be experimented with the CGE model for Uganda. Note that these simulations have been selected based on the country's overall poverty reduction and growth strategy as stipulated in Uganda's National Development Plan. Finally, a sensitivity analysis is performed on the model using alternate trade parameters and new factor market closures to ensure consistency of our simulations.

7.2 Design of Simulations

7.2.1 Simulation 1: Increase in the World Price of Exports (*PWE_INCR*)

This experiment is aimed at testing the sensitivity of Uganda's economy to changes in world commodity prices. We analyse the impact of a 30 percent increase in the world price of commodity exports. The export sector is critical to Uganda's growth and poverty alleviation strategy because the country generates significant export revenues from the sale of primary processed products (mainly coffee, cotton, tea, tobacco, fish, tea, etc.) to the world market. We hypothesize that the increase in the world price of exports significantly increases Uganda's exports volume and export revenues. The increase in export revenues would improve the country's trade balance and terms of trade. This experiment is further motivated by the fact that trade liberalisation (i.e. through the promotion of increased food processing and value added exports) is one of the key pillars of Uganda's poverty reduction strategy paper or the National Development Plan (PRSP, 2010-2011-2014/2015). It has been suggested that increasing value added exports is critical in attaining macroeconomic stability (e.g. by stabilising the country's currency and reducing the trade deficit[24] while providing incentives to poverty alleviation through increased agricultural production and food processing. Uganda's main traditional exports include coffee, cotton, tea and tobacco. Non-traditional exports include processed fish, beans, maize, hides and skins, among others.

Coffee and fish accounted for over 20 percent of the total exports between 2002 and 2003 on average (Table 7.2.1). To accommodate other commodity exports,

[24] See Chapter 2, section 2.5.

this study examines the economy wide effects of an additional 30 percent increase in the world price of exports.

Table 7.2.1 Commodity Exports in Uganda, 2002

Year	2000	2001	2002	2003	2004	2005	Average
Coffee	31.2	21.6	20.7	18.8	18.7	21.3	22.1
Cotton	5.5	3	2	3.3	6.4	3.5	4
Tea	9.2	6.6	6.7	7.2	5.6	4.2	6.6
Tobacco	6.7	7.1	9.7	8.1	6.1	3.9	6.9
Fish	7.7	17.3	18.8	16.5	15.5	17.6	15.6
Flowers	2.5	3.3	3.8	4.1	4	3	3.5
Vanilla	0.2	0.5	1.5	2.5	0.9	0.8	1.1
TEs	52.6	38.3	39.1	37.3	36.8	32.9	39.5
NTEs	47.4	61.7	60.9	62.7	63.2	67.1	60.5
Total (TES+NTEs)	100	100	100	100	100	100	

Source: Statistical Abstracts (2005, 2006) and Bank of Uganda Annual Reports (2009/2010). TEs: Traditional Exports. NTEs: Non-Traditional Exports.

In order to analyse the effects of this simulation in the CGE model, the experiment is treated as price shock (i.e. an increase in the world price of Uganda's commodity exports by 30 percent). This is due to the fact the model treats export quantities as endogenous and therefore cannot be used as a policy variable. On the other hand, the world export price is fixed in the model due to the small country assumption. This implies that Uganda is able to export any amount at the prevailing world export price. For simulation purposes, this experiment can be mathematically expressed as follows:

$$PWE\_INCR(CE, \text{'}SIM\text{'}) = 1.3 * PWE0\ (CE);\ CE \subset C \qquad (7.2.1)$$

where

PWE_INCR(CE,'SIM') is the parameter for the simulation representing the increase in world export price defined over the set of exported commodities; and *PWE0(CE)* is the parameter representing the base/initial world price of the exported commodity. *C* is the set of all commodities, and *CE* is the set of exported commodities.

7.2.2 Simulation 2: Decrease in Import Tariffs (*TAR_CUT*)

The simulation to analyse the economy wide effects of trade liberation is motivated by three key factors. First, given the central role of households, an appropriate household disaggregation would provide deeper insight into the effect of domestic policy reform on household welfare. Second, to extend the regional coverage of household welfare-based CGE models which have recently concentrated on West African Economies (i.e. Gambia, Cameroun, Cote d'Ivore) to cover Uganda which undertook massive trade reforms since 1990 and has been regarded as a success story. Third, we are able to simulate actual tariff reforms undertaken in Uganda, thus introducing realism in the model in contrast to most CGE studies that simply uses tariff changes.

This experiment examines the economy wide impacts of reducing all tariffs on imported commodities by 50 percent (i.e., partial trade liberalisation). It is equivalent to a 6 percent decline in base government revenue. Several studies have found that trade liberalisation can significantly contribute to economic growth and poverty alleviation (Winters *et al*., 2004; Robinson *et al*., 2006; Ravalllion *et al*., 1996; Hertel *et al*., 2001; and Ganuza *et al*., 2005). On the other hand, trade liberalisation increases household welfare through its linkages with factor markets. The importance of trade for poverty reduction has been recognized by the government in various Poverty Reduction Strategy Papers and the country's National Development Plan (PRSP, 2010/2011-2014/2015).

Uganda's imports are mainly manufactured goods such as heavy machinery and equipment, petroleum products, chemicals, cars, and textiles. As a dependent and land locked country, it is extremely difficult to reduce the volume of such vital imports. Lowering tariff barriers is one of the incentives to encourage such imports by domestic importers. Taxes on imported commodities derived from the SAM range between 10 percent and 18 percent for primary and manufactured goods. On the other hand, the weighted average tariff rates for agricultural commodities were 2.5 percent and 2.8 percent between 2000 and 2002. For mineral commodities, the tariff rates were 6.4 percent and 7.2 percent during the same period. The average weighted tariff rates for manufactured commodities were 8.1 and 8.2 percent respectively. Other commodities had an average weighted tax rate of between 14 percent and 15 percent respectively (Uganda Diagnostic Trade Integration Study DTIS, 2006). The trend of declining import tariffs to nearly complete full trade liberalisation (i.e., zero tariffs for some goods) is expected to continue as Uganda is a member of the East African Customs Union) and the Common Market for Eastern and Southern Africa (COMESA). The technical implementation of this experiment is such that the base year tariff parameter *tm0*(*CM*) is multiplied by 0.5. This can be expressed as follows:

$$TAR\_CUT\ (CM,\ \text{‘}SIM\text{’}) = 0.5{*}tm0(CM); \quad CM \subset C \tag{7.2.2}$$

where

TAR_CUT(CM, ‘SIM’) is the parameter for the simulation representing the decrease in tariff rates for a set of imported commodities, *CM*; and *tm*0*(CM)* is the base year tariff rate for the imported commodity.

7.2.3 Simulation 3: Increase in Workers’ Remittances (*REMIT_INCR*)

This dissertation is the first of its kind to apply the CGE modelling framework to analyse the economy wide effects of increasing migrant’s workers’ remittances in Uganda.

This simulation involves transfers from Ugandans living and working abroad (rest of the world) to Ugandan households. The shock involves two steps: First, whereas transfers between households are endogenous in the model, transfers from government to households $TR_{h,g}$ and from the rest of the world to households $TR_{h,r}$ are fixed (exogenous). Thus, to shock the residual value of transfers from the rest of the world to households (a residual value in the SAM), a parameter equal to the fixed base value of transfers, from the rest of the world to households, *REMIT_INCR (‘H’,* *'BASE')* is generated. The simulated parameter is then equated to the desired increase in the fixed level of workers remittances, *REMIT_INCR ('H', 'SIM')*. Note that we are increasing the currency value of transfers from the rest of the world to all the 8 household categories in the SAM (i.e. all household groups received transfers from abroad in form of workers remittances). Thus,

REMIT_INCR(H, 'BASE') = TR0(H,'R');

*REMIT_INCR(H,'SIM') = 1.4*TR0(H,'R');*

$$TR.FX\ (H,'R') = TR0\ (H,'R'). \qquad (7.2.3)$$

REMIT_INCR (*H*, *'SIM'*) is the parameter for the simulation representing the increase in remittances from the rest of the world *R* to domestic household category, *H; and TR0* (*H,'R'*) is the corresponding base value of workers remittances to household category, *H*. The base value of household remittances is fixed, *TR.FX (H, 'R')* during simulations. The base value of remittances is the row of the households account and column of the rest of the world account in the SAM.

This simulation analyses the effects of a 40 percent increase in migrant remittances (i.e. factor income transfers from the rest of the world to Ugandan households). This experiment is equivalent to an increase of Uganda shillings 334.5 billion from the base value of migrant remittances. The magnitude of this simulation is due to the fact that migrant remittances increased by 35 percent between 1996 and 2003 and 22 percent between 2009 and 2010 (Bank of Annual Reports, 1995-2010). We assume a further increase in migrant remittances by 40 percent and analyse the effects of these inflows on macroeconomic variables, household welfare, sectoral output and employment. The detailed importance of migrant remittances is explained in Chapter 2.

7.2.4 Simulation 4. Increase in Foreign Savings (*FSAV_INCR*)

Our interest is to model a 40 percent increase in the base value of foreign direct investment in Uganda. It should be noted investment is fixed in all simulations. Thus, foreign investment replaces domestic investment for some existing projects. Foreign Direct Investment accounted for 25 percent of total investment in 2002. This simulation is intended to allow flexibility in Uganda's BOP account i.e. Uganda could increase her foreign debt to finance development programs. The link through which foreign savings affect other variables in the Ugandan economy is through exchange rate appreciation or depreciation[25]. Exchange rate depreciation leads to an increase in exports QE_c; while an appreciation of the exchange rate causes an increase in imports, QM_c. The changes in real exports and imports are transmitted to the rest of the economy through sectoral linkages (Thurlow, *et al.*, 2009).

This experiment is equivalent to an injection of Uganda shillings 191.4 billion (12.6 percent of base 2002 exports). Foreign Direct Investment inflows increases domestic savings and thus play a vital role in the process of capital accumulation by making capital available for investment (Chitiga and Kandiero, 2003). In addition, FDI improves resource allocation and reduces the cost of local capital (Todaro, 2000).

The implementation of this simulation is rather straight forward. The fixed value of foreign savings *FSAV* is multiplied by the desired percentage increase. The simulated value of foreign savings is the row of the rest of the world account and column of the savings-investment account in the SAM. Based on past and present trends, this dissertation analyses the economy wide effects of a 40 percent increase in the base level of foreign savings.

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25 $$\sum_{c \in C} pwm_c \, QM_c + \sum_{i \in ID} TR_{r,i} / EXR + \sum_{f \in F} Y_{r,f} / EXR = \sum_{c \in C} pwe_c \, QE_c + \sum_{i \in ID} TR_{i,r} + \overline{FSAV}$$

$$FSAV\_INCR\ (\text{'}SIM\text{'}) = 1.4*FSAV0; \qquad (7.2.4)$$

where

FSAV_INCR is the parameter for the simulation representing the increase in foreign savings; *FSAV0* is the parameter representing the base value of fixed foreign saving which is fixed based on the exchange rate closure adopted in this study.

A detailed description of economy wide effects of all simulations is presented in the next section. Note that when the model is simulated, all endogenous variables change. The results presented are only part of the large number of endogenous variables and parameters. Other results, including GAMS output can be made available on request. Where appropriate, closure rules are used to explain how equilibrium in achieved (i.e. current account equilibrium, savings-investment adjustment, factor market equilibrium, and exchange rate adjustment).

7.3 Simulation 1. A 30% Increase in the World Price of Exports (*PWE_INCR*)

7.3.1 Impact on Real GDP Measures

The simulation results presented in Table 7.3.1 suggest that an increase in the world price of exports has a positive impact on real GDP. Overall, real GDP at factor cost increases by 9 percent while real GDP at market prices increases by 7.7 percent.

Table 7.3.1 Effects of 30% Increase in the World Price of Exports on Real GDP

	Factor income, Y_f (base)	Factor income, Y_f (shocked)	% Change
Low skilled-rur-male	580,834	673,655	16
Low skilled-rur-female	99,249	114,893	16
Low skilled-urb-male	192,656	225,488	17
Low skilled -urb-female	75,164	89,464	19
High skilled-rur-male	718,471	777,999	8.3
High skilled-rur-female	244,233	264,574	8.3
High skilled-urb-male	1,052,894	1,140,631	8.3
High skilled-urb-female	426,968	463,090	8.5
Capital	6,671,989	7,221,632	8.2
Total Factor Income	10,062,459	10,971,428	9.0
Real GDP at Factor Cost	10,062,460	10,971,430	9.0
Real GDP at Market Price	28,596,660	30,810,400	7.7

Source: Own computations. CGE model results: Figures are in Millions of Uganda shillings.

The increase in the world price of exports leads to changes in sectoral output, income and employment in sectors with significant linkages to the export sector. For example, an increase in world export price causes reallocation of resources to sectors with strong linkages to the export market (i.e. Agriculture, Manufacturing, Food Processing, and Trade Services) to increase production for the domestic market, QD_c and exports, QE_c. In order to increase production, producers increase demand for factors, which lead to increase in employment $QF_{f,a}$, value added QVA_a, factor and household incomes. The effect of a 30 percent increase in the world price of exports on value added and price of value added (unit gross revenue) is presented in Table 7.3.2.

Table 7.3.2 Impact of an Increase in World Export Price on Real Value Added

Activity	PVA_a base	PVA_a shocked	% Change	QVA_a base	QVA_a shocked	% Change
Agriculture	0.75	0.80	5.9	2,693,357	2,933,588	8.9
Mining	0.69	0.70	2.9	33,999	35,469	4.3
Food Processing	0.15	0.20	9.2	314,880	369,961	17.5
Manufacturing	0.08	0.10	5.1	112,548	118,845	5.6
Utilities	0.79	0.90	8.9	389,814	425,408	9.1
Construction	0.58	0.60	7.7	1,166,063	1,262,576	8.3
Trade Service	0.64	0.70	10.3	1,186,509	1,332,429	12.3
Transport	0.62	0.60	2.6	335,193	342,558	2.2
Health and Education	0.61	0.70	8.1	1,007,943	1,098,614	9.0
Other Services	0.57	0.60	7.7	2,820,994	3,054,568	8.3
Value added GDP				*10,061,300*	*10,974,014*	*9.0*

Source: Own computations. CGE Model Results. Value added is in millions of Uganda shillings.

From the table above, sectors with significant linkages with the export sector experience an increase in their value added output. These include: Food Processing (17.5 percent), followed by Trade Services (12.3 percent), Utilities (9 percent), Agriculture (8.9 percent), and Construction (8.3 percent).Mining, Manufacturing, and Transport were identified as sectors with weak linkages to the rest of the economy and therefore experience a relatively small increase in their value added.

7.4.2 Effect on the Current Account Balance, Imports and Exports

The role of the foreign exchange closure assumed (flexible exchange rate, fixed foreign savings) is to bring about equilibrium in the current account. From the current account balance[26], only real exports (*QE*) and real imports (*QM*) are the only variables allowed to adjust. Transfers (*TR*) and foreign savings (*FSAV*) are fixed. An increase in world price of exports causes the foreign currency value of exports to increase relative to imports, creating a surplus on the current account (i.e. net exports = QE_c-QM_c>0). To restore current account equilibrium, imports should increase and this incentive is provided by an exchange rate appreciation. Simulation results presented in Table 7.4.2 below suggest that the real value of exports increases by 35.5 percent and this is achieved by 15.3 percent appreciation of the exchange rate (i.e. the local currency, Uganda shilling appreciates). Exchange rate appreciation causes the price of imports to fall, resulting into an increase in demand for imports and consequently an increase in the volume of imports. Our results suggest that real imports increases by 6 percent and this increase restores equilibrium on the current account. The impact of the shock on real exports and imports is presented in Table 7.4.2 and Table 7.4.3 below respectively.

Table 7.4.2 Impact of a 30% Increase in World Export Price on Export Prices and Quantity

Commodity	PE_c base	PE_c shocked	% Change	QE_c base	QE_c shocked	% Change
Agriculture	1	1.1	10.1	293,230	334,066	13.9
Mining	1	1.1	10.1	10,285	11,254	9.4
Food Processing	1	1.1	10.1	447,599	547,789	22.4
Manufacturing	1	1.1	10.1	159,465	294,561	84.7
Utilities	1	1.1	10.1	27,144	29,206	7.6
Trade Services	1	1.1	10.1	118,719	129,678	9.2
Transport	1	1.1	10.1	88,428	106,840	20.8
Other Services	1	1.1	10.1	369,419	409,982	11.0
Total Exports				*1,514,289*	*2,051,287*	*35.5*

Source: Own computations. CGE Model Results. Value of Imports in Millions of Uganda Shillings.

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[26] $$\sum_{c \in C} pwm_c\, QM_c + \sum_{i \in ID} TR_{r,i} / EXR + \sum_{f \in F} Y_{r,f} / EXR = \sum_{c \in C} pwe_c\, QE_c + \sum_{i \in ID} TR_{i,r} + \overline{FSAV}$$

Table 7.4.3 Impact of a 30% Increase in World Export Price on Real Quantity of Imports, QM_c

Commodity	PM_c base	PM_c shocked	% Change	QM_c base	QM_c shocked	% Change
Agriculture	1	0.85	-15.3	96,152	162,529	69.0
Mining	1	0.85	-15.3	29,618	33,717	13.8
Processed Foods	1	0.85	-15.3	235,220	340,321	44.7
Manufacturing	1	0.85	-15.3	2,361,146	2,795,443	18.4
Transport	1	0.85	-15.3	388,694	491,100	26.3
Other Services	1	0.85	-15.3	224,730	330,337	46.9
Total Imports				*2,950,080*	*3,126,510*	*5.98*
Exchange Rate	*1*	*0.85*	*-15.3*			

Source: Own computations. CGE Model Results. Value of Imports in Millions of Uganda Shillings.

Increasing the world price of exports increases Uganda's exports and imports significantly through import and export price adjustments and exchange rate appreciation. Exports of manufactured goods (85 percent) are the highest followed by processed foods (22 percent), transport Services (21 percent), agricultural goods (13.9 percent), other services (11 percent) and Trade Services (9 percent). The appreciation of the exchange rate, *EXR* and decline in domestic price of imports PM_c leads to an increase in real imports of agriculture goods (69 percent), followed by other service goods (47 percent), processed foods (45 percent), Transport Services (26 percent), and trade services (18 percent), and mining goods (13.8 percent).

To sum it all, an increase in the world price of exports results into an increase in real exports and a current account surplus (i.e. current account disequilibrium). To restore equilibrium, the exchange rate appreciates leading to an increase in imports. By the definition of GDP by the expenditure approach[27], total absorption[28] is the sum of real GDP and the trade balance, QE_c-QM_c. Since government expenditure and investment are fixed, private consumption increases to maintain an increase in real GDP. Private consumption increases because the increase in exports leads to an increase in employment, factor and household incomes. The net effect is an increase in private consumption by 6.2 percent.

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[27] $GDP = C + \bar{I} + \bar{G} + QE - QM$

[28] Total Absorption = $C + \bar{I} + \bar{G}$ = *GDP + (QM-QE)*

7.5.3 Impact of World Export Price on the Savings-Investment Balance

From the definition of the savings investment gap[29], investment, $QINV_c$ and foreign savings, $FSAV$ are fixed. Closing the investment-savings gap following the increase decrease in private savings $DSAV_h$ and government savings $DSAV_g$ would require the domestic demander price of investment goods PQ_c to increase. The commodities whose composite price PQ_c increase following a 30 percent increases in the world price of exports are: utilities (7 percent), trade service goods (5.7 percent), health and education services (4.6 percent), and agricultural goods (3 percent). The increase in the price PQ_c paid by domestic demander's increases the domestic supply QQ_c of all commodities (Table 7.5.3). The increase in the quantity of goods supplied to the domestic market QQ_c is led by Transport services (7.8 percent). This is followed by manufactured goods (7.6 percent), processed food products (6.7 percent), mining goods (5 percent) and agricultural goods (3.6 percent).

Table 7.5.3 Impact of Export Price on Composite Price and Domestic Supply

Commodity	PQ_c base	PQ_c shocked	% Change	QQ_c base	QQ_c shocked	% Change
Agriculture	1.02	1.05	3.0	3,096,590	3,209,567	3.6
Mining	1.03	0.95	-7.4	70,472	74,043	5.1
Food Processing	1.06	1.05	-1.4	2,134,654	2,276,920	6.7
Manufacturing	1.03	0.89	-13.2	3,756,474	4,039,850	7.5
Utilities	1.05	1.12	7.2	458,716	458,032	-0.1
Construction	1.01	1.01	0.9	2,045,529	2,055,504	0.5
Trade Service	1.00	1.06	5.7	1,865,964	1,887,745	1.2
Transport	1.02	0.94	-8.0	955,690	1,032,150	8.0
Health and Education	1.03	1.07	4.6	1,853,409	1,869,031	0.8
Other Services	1.01	1.04	2.7	4,294,379	4,371,220	1.8

Source: Own Computations. CGE Model Results. Quantities in Millions of Uganda Shillings.

7.5.4 Impact on the Activity Gross Revenue and Prices

The effects of a 30 percent increase in the world export price results in a reallocation of resources to those sectors that have linkages with the export market. Producers react by employing more factors to produce for the domestic and export

[29] $PQ_C * \overline{QINV_C} = DSAV_{IDNG} + DSAV_G + EXR * \overline{FSAV}$

market. This consequently increases household and factor incomes. The quantity or level of each activity QA_a increases (Table 7.5.4).

Table 7.5.4 Impact of Increased Export Price on Activity Output and Activity Price

	PA_a base	PA_a shocked	% change	QA_a base	QA_a shocked	% Change
Agriculture	1	1.04	4.4	3,600,745	3,867,285	7.4
Mining	1	1.01	1.0	49,203	50,385	2.4
Food Processing	1	1.02	1.8	2,044,673	2,227,578	8.9
Manufacturing	1	0.95	-5.5	1,500,644	1,421,733	-5.3
Utilities	1	1.07	7.3	490,949	528,405	7.6
Construction	1	1.01	0.9	2,013,926	2,042,529	1.4
Trade Service	1	1.06	5.8	1,859,732	2,001,539	7.6
Transport	1	1.00	-0.3	543,263	539,730	-0.7
Education and Health	1	1.04	4.3	1,649,661	1,736,257	5.2
Other Services	1	1.04	4.4	4957810	5204097	5.0

Source: Own Computations. CGE Model Results. Quantities in Millions of Uganda Shillings.

7.6 Microeconomic Effects

7.6.1 Impact of World Export Price on Factor Incomes

Increasing world export prices increases the supply of goods and services for the domestic market QQ_c as presented above and exports QE_c. To sustain this increase in supply, producers demand more factors of production $QF_{f,\ a}$. This consequently increases factor and household incomes (Table 7.6.1).

Table 7.6.1 Effect of a 30% Increase in World Export Price on Factor Incomes, Y_f

Factor	Factor income, Y_f (base)	Factor income, Y_f (shocked)	% Change
Low skilled-rur-male	580,834	673,655	16
Low skilled-rur-female	99,249	114,893	16
Low skilled-urb-male	192,656	225,488	17
Low skilled -urb-female	75,164	89,464	19
High skilled-rur-male	718,471	777,999	8.3
High skilled-rur-female	244,233	264,574	8.3
High skilled-urb-male	1,052,894	1,140,631	8.3
High skilled-urb-female	426,968	463,090	8.5
Capital	6,671,989	7,221,632	8.2

Source: Own Computations. CGE Model Results. Factor Income in Millions of Uganda Shillings.

Our findings above suggest that the demand for low skilled labour increases significantly. Specifically, the employment of low skilled urban female and male labour increases by 19 percent and 17 percent respectively. The corresponding increase in incomes for rural based low skilled labour is 16 percent for both labour categories. Given that we assumed flexible employment and fixed wages for low skilled labour, factor returns for these factors increase by the same percentage as the labour demand. As for high skilled labour, the full employment closure (i.e. fixed employment and flexible wages) and thus, the demand for these factors remain unchanged. However, returns for these factors freely adjust to clear their factor markets. The final result is an increase in the wage of high skilled labour by 8.3 percent.

7.6.2 Effect on Factor Demands $QF_{f,\,a}$ and Household Incomes, Y_h

The reallocation of resources to sectors with strong linkages to the export sector leads to increase in demand for factors of production $QF_{f,a}$ (Table 7.6.2). The increase in factor employment leads to an increase in household incomes (Table 7.6.3).

Table 7.6.2 Impact of World Export Price Increase on Factor Demands, $QF_{f,\,a}$

Factor	$QF_{f,\,a}$ Base	$QF_{f,\,a}$ Shocked	% Change
Capital	6,671,988	6,671,988	0
High skilled-rur-male	353,158	353,158	0
High skilled-rur- female	177,366	177,366	0
High skilled -urb-male	127,725	127,725	0
High skilled-urb- female	78,246	78,246	0
Low skilled -rur- male	3,403,842	3,945,053	16
Low skilled - rur-female	4,045,634	4,684,844	16
Low skilled- urb-male	527,275	616,912	17
Low skilled-urb-female	542,754	645,877	19

Source: Own Computations. CGE Model Results. rur: rural; urb: urban.

Table 7.6.3 Impact of an Increase in World Export Price on Household Incomes, Y_h

Household category	Y_h Base	Y_h Shocked	% Change
Central-rur- households	2,258,541	2,394,053	6.0
Central-urb-households	3,569,255	3,804,826	6.6
Eastern-rur- households	1,631,092	1,712,647	5.0
Eastern-urb-households	488,895	509,429	4.2
Northern-rur-households	811,467	857,721	5.7
Northern-urb-households	263,477	275,860	4.7
Western-rur-households	1,737,154	1,858,755	7.0
Western-urb-households	663,268	711,023	7.2

Source: Own Computations. CGE Model Results. Incomes in Millions of Uganda Shillings.

The increase in household incomes is more significant for households endowed with skilled labour and capital. In Uganda, these households live in the central and western regions as wealthy business and farm owners. This therefore explains why the incomes of central rural and households increased by 6 percent and 6.6 percent respectively following the increase in world export prices. The corresponding increase for western urban and rural households is 7.2 percent and 7 percent respectively. For households residing in the northern and eastern regions of the country, rural households benefit more than their urban counterparts following the shock. The increase in income is 5.7 percent and 4.7 percent for northern rural and northern urban households respectively. For eastern rural households, their incomes increase by 5 percent compared to 4.2 percent for urban households. The employment of capital and high skilled labour is fixed by the closure rule and therefore no change in employment is registered after the shock.

7.6.4 Impact of World Export Price on Household Expenditures, $EXPE_h$

An increase in household incomes leads to an increase in household total expenditures[30] (Table 7.6.4). Households located in western and central Uganda and whose incomes increase significantly after the shock experience a relatively higher increase in their total expenditure. Specifically, the total expenditure of central region rural and urban households increases by 5.8 percent and 7.2 percent respectively. The total expenditure of western rural and urban households increases by 6.9 percent and 9 percent respectively. Households in the eastern region experience a 4.9 percent and 4.7 percent increase in their expenditures respectively. Total expenditures by northern rural and urban household’s increases by 5.7 percent and 5.1 percent following the increase in the world price of exports. Generally, all households benefit following the shock.

Table 7.6.4 Impact on Increase in World Export Price on Household Expenditures, $EXPE_h$

Household Category	Expenditure (Base)	Expenditure (shocked)	% change
Central-rur-households	2,170,576	2,296,469	5.8
Central-urb- households	1,984,724	2,127,624	7.2
Eastern-rur-households	1,590,353	1,668,280	4.9
Eastern-urb-households	306,818	321,238	4.7
Northern-rur-households	797,349	842,798	5.7
Northern-urb- households	141,253	148,457	5.1
Western-Rural Households	1,680,815	1,796,791	6.9
Western-Urban Households	319,797	347,300	8.6

Source: Own Computations. CGE Model Results. Expenditures in Millions of Uganda Shillings.

[30] $EXPE_h = (1-ty_h)*Y_h - DSAV_h - TR_{IDNG,IDNG'} - TR_{r,h}$
Expenditure of household is what remains after household savings, and transfers between households and to the rest of the world have been deducted from after tax household income.

7.7 Impact of an Increase in World Export Price on Job Creation

An increase in the world price of exports results into increased demand for factors to increase domestic production for export. Sectors with significant linkages to the export market employ more labour, especially low skilled labour following the increase in the world price of exports (Table 7.7.1). Specifically, the number of jobs created is higher for rural based female workers (637,723 jobs), followed by low skilled rural male workers (543,995 jobs). Rural female jobs contributed about 46 percent of total jobs created, while rural male jobs contributed 40 percent of total employment created. The employment of high skilled labour and capital is fixed by the closure rules adopted and thus, no jobs are created for these types of factors. The number of low skilled labour jobs created is higher in rural areas because of the strong linkages of the export sector to agriculture which is the largest employer in Uganda. In addition, our results suggest that agriculture is the largest employer of low skilled labour in Uganda, with about 60 percent of low skilled labour jobs provided by the sector (Table 7.7.2).

Table 7.7.1 Impact on Total Employment of Low Skilled Labour

	Base	Shock Effect	Share in Jobs Created
Low Skilled, Rural Male	3,403,842	543,955	39.6%
Low Skilled, Rural Female	4,045,634	637,723	46.4%
Low Skilled, Urban Male	527,275	89,855	6.5%
Low Skilled Urban Female	542,754	103,258	7.5%
Total Jobs created/share	*8,519,505*	*1,374,791*	100%

Source: Own Computations. CGE Model Results.

Table 7.7.2 Impact of Export Price on Sectoral Employment of Low Skilled Labour

Sector	Base values	Shocked values	Share in Jobs Created
Agriculture	5,393,553	824,815	60%
Mining	50,260	3,646	0.3%
Food Processing	447,009	123,791	9.0%
Manufacturing	158,919	17,009	1.2%
Utilities	5,871	1,107	0.1%
Construction	157,761	26,177	1.9%
Trade Service	257,036	61,258	4.5%
Transport	233,469	11,313	0.8%
Health & Education	379,492	67,751	4.9%
Other Services	1,436,135	237,924	17.3%
Total Jobs created/share	*8,519,505*	*1,374,791*	*100%*

Source: Own Computations. CGE Model Results.

Other sectors with a significant increase in low skilled labour jobs include: Other Services (17.3 percent), Food Processing (9 percent), Education and Health (4.9 percent), and Trade Services (4.5 percent). Regarding the employment of high skilled labour jobs (Table 7.7.3), the net effect on employment is zero with some sectors experiencing job losses while others experience positive changes in employment. Note that the employment of high skilled labour and capital is fixed in this study.

Table 7.7.3 Impact of Export Price on Sectoral Employment of High Skilled Labour

Sector	Employment, $QF_{f,a}$ (base values)	Employment, $QF_{f,a}$ (shocked)
Agriculture	38,651	-659
Mining & Quarrying	8	-1
Food Processing	14,149	1,250
Manufacturing	19,815	-1,112
Utilities	15,843	201
Construction	36,977	-214
Trade Service	24,886	1,362
Transport	4,657	-1,158
Health & Education	320,708	1,462
Other Services	260,801	-1,790
Total jobs created	*736,495*	*0*

Source: Own Computations. CGE Model Results.

7.8 Experiment 2: A 50% Decrease in Import Tariffs (*TAR_CUT*)

7.8.1 Impact on Real GDP at Factor and Market Prices

The net effect of a 50 percent decrease in tariffs on all imported commodities is an increase in real GDP at factor cost and market price by 1.8 percent and 1.2 percent respectively (Table 7.8.1).

Table 7.8.1 Impact of Tariff Cuts by 50% on Real GDP

.	Factor Income (Base)	Factor Income (Shocked)	% change
Low skilled-rur-male	580,834	599,536	3.2
Low skilled-rur-female	99,249	102,581	3.4
Low skilled-urb-male	192,656	198,416	3.0
Low skilled -urb-female	75,164	78,598	4.6
High skilled-rur-male	718,471	728,998	1.5
High skilled-rur-female	244,233	248,186	1.6
High skilled-urb-male	1,052,894	1,070,237	1.6
High skilled-urb-female	426,968	434,028	1.7
Capital	6,671,989	6,784,841	1.7
Total Factor Income/value added	*10,062,459*	*10,245,420*	*1.8*
Real GDP at factor cost	*10,062,459*	*10,245,420*	*1.8*
Real GDP at Market Price	*28,596,600*	*28,930,600*	*1.2*

Source: Own Computations. CGE Model Results. Factor Incomes in Millions of Uganda Shillings.

A decrease in import taxes results in the decrease in domestic price of imports, PM_c. The decrease in import price leads to an increase in demand for imported goods, QM_C which causes a shift in the demand curve towards imports (Thurlow *et al*., 2002). On the other hand, domestic buyers substitute imports for goods produced and sold domestically, QD_c. The increase in demand for domestic output leads to the increase in the supply price PD_c of goods produced and sold domestically, QD_c. To increase the supply of goods in the domestic market, producers increase their demand for factors of production, $QF_{f,a}$ which in turn increases factor, Y_f and household incomes, Y_h. The value added of some sectors increase as a result. The net effect is an increase in real value added by 1.8 percent (Table 7.8.2). The increase in sectoral value added is led by Transport Services (4 percent), followed by Food Processing (3 percent), Agriculture (1.9 percent), Other Services (1.9 percent), Trade Services (1.6 percent), and Utilities (1.5 percent). Value added by manufacturing declines owing to import competition which reduces demand for domestically manufactured goods and thus output from this sector.

Table 7.8.2 Impact of Tariff Cuts on Sectoral Value Added and Real GDP

Activity	PVA_a base	PVA_a shocked	% change	QVA_a base	QVA_a shocked	% change
Agriculture	0.75	0.76	1.28	2,692,669	2,744,305	1.92
Mining	0.69	0.70	0.74	34,013	34,390	1.11
Food Processing	0.15	0.16	1.74	315,700	325,277	3.03
Manufacturing	0.075	0.08	0.94	113,004	110,894	-1.87
Utilities	0.79	0.81	1.54	389,831	395,825	1.54
Construction	0.58	0.59	1.41	1,166,230	1,183,582	1.49
Trade Service	0.64	0.65	1.45	1,186,435	1,205,098	1.57
Transport	0.62	0.64	3.03	335,138	348,653	4.03
Health and Education	0.61	0.62	1.48	1,007,824	1,022,285	1.43
Other Services	0.57	0.58	1.61	2,821,614	2,875,112	1.90
Real GDP at factor cost				*10,062,459*	*10,245,420*	*1.82*

Source: Own Computations. CGE Model Results. Value added in Millions of Uganda Shillings.

7.8.3 Impact on the Current Account Balance, Imports and Exports

The role of the foreign exchange closure assumed (flexible exchange rate, fixed foreign savings) is to bring about equilibrium in the current account. From the current account balance[31], only real exports (QE) and real imports (QM) are the only variables allowed to adjust. Transfers (TR) and foreign savings ($FSAV$) are fixed. A decline in import tariffs causes the decline in domestic import price, PM_c of some goods which increases demand for imports QM_c. The increase in imports leads to a trade deficit on the current account (i.e. net exports, QE_c-QM_c<0). To restore current account equilibrium, it would require an increase in exports. The increase in exports is provided by exchange rate EXR depreciation and an increase in the domestic price of exports (Table 7.8.3). The aggregate value of imports and exports increases by 5.7 percent and 7.4 percent respectively following the depreciation of the exchange rate by 2.4 percent (Table 7.8.3 and Table 7.8.4).

Table 7.8.3 Impact of Tariff cuts on Import Price and Imports

Commodity	PM_c base	PM_c shocked	% change	QM_c base	QM_c shocked	% change
Agriculture	1	1.02	1.8	96,152	94,236	-2.0
Mining	1	0.99	-1.3	29,618	29,792	0.6
Processed Foods	1	0.99	-1.3	235,220	243,450	3.5
Manufacturing	1	0.95	-5.5	2,361,146	2,483,019	5.2
Transport	1	1.02	2.4	388,694	381,983	-1.7
Other Services	1	1.02	2.4	*224,730*	*218,615*	-2.7
Total Real Imports				*2,950,080*	*3,118,349*	*5.7*
Exchange Rate	*1.0*	*1.02*	*2.4*			

Source: Own Computations. CGE Model Results. Imports in Millions of Uganda Shillings.

Table 7.8.4 Impact of Tariff Cuts on Export Price and Exports

Commodity	PE_c base	PE_c shocked	% change	QE_c base	QE_c shocked	% change
Agriculture	1	1.024	2.4	293,230	302,955	3.3
Mining	1	1.024	2.4	10,285	10,508	2.2
Food Processing	1	1.024	2.4	447,599	468,001	4.6
Manufacturing	1	1.024	2.4	159,465	186,581	17.0
Utilities	1	1.024	2.4	27,144	28,059	3.4
Trade Services	1	1.024	2.4	118,719	122,031	2.8
Transport	1	1.024	2.4	88,428	90,945	2.8
Other Services	1	1.024	2.4	369,419	380,066	2.9
Total Real Exports				*1,514,289*	*1,626,797*	*7.4*

Source: Own Computations. CGE Model Results. Exports in Millions of Uganda Shillings.

The increase in imports, QM_c following the decline in import tariffs, tm_c is led by imports of manufactured goods (5.2 percent) and processed food products (3.5 percent). The increase in the relative price of some imported goods leads to a decline in their import quantities. Imports of agricultural goods, transport and other services

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[31] $$\sum_{c\in C} pwm_c\, QM_c + \sum_{i\in ID} TR_{r,i} / EXR + \sum_{f\in F} Y_{r,f} / EXR = \sum_{c\in C} pwe_c\, QE_c + \sum_{i\in ID} TR_{i,r} + \overline{FSAV}$$

decline after the shock to import tariffs and the increase in domestic import prices of these goods. A depreciation of the exchange rate and an increase in the domestic price of exports lead to an increase in exports. The increase in exports is dominated by manufactured goods (17percent), followed by processed food products (4.6 percent), Utilities (3.4 percent), agricultural goods (3.3 percent), and Other Services (2.9 percent).

To sum it all, a decline in import tariffs results into an increase in real imports QM_c and a current account deficit (i.e. current account disequilibrium). To restore equilibrium, exports QE_c increases. The increase in exports is provided for by the depreciation of the exchange rate. Using the definition of GDP by the expenditure approach[32], total absorption[33] is the sum of real GDP and the trade balance QE_c-QM_c. Since government expenditure and investment are fixed, private consumption would have to increase to maintain an increase in real GDP. Private consumption increases because the increase in demand and substitution of some imports for domestically produced goods leads to an increase in employment and factor incomes. The net effect is an increase in real GDP at factor and market prices, and private consumption by 1.8 percent, 1.2 percent and 0.7 percent respectively.

7.8.5 Impact of Tariff Cuts on the Savings-Investment Balance

From the definition of the savings investment gap[34], investment $QINV_c$ and foreign savings *FSAV* are fixed. Closing the investment-savings gap following the increase in private savings $DSAV_h$ would require a decrease in public savings and an increase in the domestic demand price of investment goods, PQ_c (Table 7.8.5). Consequently, domestic savings increases by 20 percent and public savings decreases

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[32] $GDP = C + \overline{I} + \overline{G} + QE - QM$

[33] Total Absorption = $C + \overline{I} + \overline{G}$ = $GDP + (QM\text{-}QE)$

[34] $PQ_C * \overline{QINV_C} = DSAV_{IDNG} + DSAV_G + EXR * \overline{FSAV}$

by 33 percent (Table 7.8.6). The increase in household savings is due to an increase in household incomes following increased factor employment. Government savings decline following an increase in government expenditure and decline in import tax revenue which consequently reduces net indirect taxes and net government revenue.

Table 7.8.5 Impact of Tariff Cuts on Composite Price and Domestic Supply

Commodity	PQ_c base	PQ_c shocked	% change	QQ_c base	QQ_c shocked	% change
Agriculture	1.02	1.03	0.85	3,096,590	3,105,594	0.29
Mining	1.03	1.02	-0.78	70,472	70,523	0.07
Food Processing	1.06	1.062	0.08	2,134,654	2,148,152	0.63
Manufacturing	1.03	0.98	-4.65	3,756,474	3,810,132	1.43
Utilities	1.05	1.058	1.09	458,716	457,730	-0.22
Construction	1.01	1.002	-0.31	2,045,529	2,046,787	0.06
Trade Service	1.00	1.01	0.88	1,865,964	1,865,298	-0.04
Transport	1.02	1.04	1.64	955,690	951,975	-0.39
Health and Education	1.03	1.033	0.63	1,853,409	1,853,472	0.00
Other Services	1.01	1.023	0.94	4,294,379	4,289,529	-0.11

Source: Own Computations. CGE Model Results. Quantities in Millions of Uganda Shillings.

Table 7.8.6 Impact of Tariff Cuts on Private and Public Savings

Household Category	Savings (Base)	Savings (shocked)	% change
Central-rur-households	68,484	81,860	20
Central-urb- households	291,113	349,103	20
Eastern-rur-households	28,037	33,573	20
Eastern-urb-households	29,690	35,557	20
Northern-rur-households	5,594	6,700	20
Northern-urb- households	14,502	17,384	20
Western-Rural Households	30,581	36,696	20
Western-Urban Households	32,000	38,385	20
Government Savings	537,969	361,365	-33
Government Income	2,571,127	2,409,032	-6.3

Source: Own Computations. CGE Model Results. Savings in Millions of Uganda Shillings.

7.8.7 Impact on Government Account Balances

Tariff cuts have a negative impact on government revenue, Y_g. Our results suggest that a 50 percent decline in import taxes reduces net indirect taxes by 21 percent and decreases government revenue by 6.3 percent. The decrease in government revenue caused by tariff cuts causes government savings, $DSAV_g$ to decrease by 3.3 percent of GDP compared to 4.9 percent of GDP in the base year. By assumption, investment and foreign savings are fixed. Private savings increases by 8.7 percent of GDP to compensate for the fall in government savings and this clears the savings investment gap[35]. In addition, the depreciation of the exchange rate, *EXR*

[35] $PQ_cQINV_c = DSAV_{IDNG}+DSAV_G+ FSAV$

provides further incentive to clear the savings-investment gap[36]. This is true because the decline in government savings, $DSAV_g$ is offset by the increase in net exports which clears the savings-investment gap since total domestic savings is equal to the sum of investment, $QINV_c$ and net exports, QE_c-QM_c.

7.9 Microeconomic Effects

7.9.1 Impact of Tariff Cuts on Factor Incomes

The reallocation of resources towards production of goods and services for the domestic market and import substitution leads to an increase in demand for factors and an increase in factor incomes (Table 7.9.1). The labour market closure assumed for low skilled labour implies that only the quantity of labour unemployed adjusts to clear the market since wages are fixed. The employment of high skilled is fixed and therefore, their wages adjust to equilibrate the labour market.

Table 7.9.1 Impact of Tariff Cuts on Factor Incomes, Y_f

Labour category	Factor Income (base)	Factor Income (shocked)	% change	Factor Pay't(base)	Factor Pay't (shocked)
Low skilled-rur-male	580,834	599,536	3.2	1	1
Low skilled-rur-female	99,249	102,581	3.4	1	1
Low skilled-urb-male	192,656	198,416	3.0	1	1
Low skilled -urb-female	75,164	78,598	4.6	1	1
High skilled-rur-male	718,471	728,998	1.5	1	1.5
High skilled-rur-female	244,233	248,186	1.6	1	1.6
High skilled-urb-male	1,052,894	1,070,237	1.6	1	1.6
High skilled-urb-female	426,968	434,028	1.7	1	1.7
Capital	6,671,989	6,784,841	1.7	1	1

Source: Own Computations. CGE Model Results. Labour Income in Millions of Uganda Shillings.

With regard to total factor income, female workers regardless of location and skill category benefit more than male workers as a result of tariff cuts. Specifically, high skilled rural females experience an increase in income of 1.6 percent compared to males (1.5 percent). Similarly, the total income for low skilled urban female's increases by 4.6 percent compared to 3 percent for males. The employment of high skilled labour is fixed and therefore, the wages for high skilled labour adjusts clear their markets. Capital is activity specific and fully employed and

[36] *Private savings+ Government savings = Investment (interest rate) + Net exports (exchange rate)*

its payment is fixed. The payment distortion for capital in each activity, $WFDIST_{k,\,a}$ adjusts to clear the capital market.

7.9.2 Impact of Tariff Cuts on Household Incomes, Y_h

The decline in import tariffs is accompanied by the depreciation of the exchange and a current account deficit**.** The depreciation of the exchange rate, *EXR* increases exports. The reallocation of resources to increase production of goods and services for the domestic market, QD_c and exports, QE_c leads to an increase in demand for factors, $QF_{f,a}$ which consequently increases household incomes, Y_h. Our findings reveal that household incomes increase significantly across all household categories (Table 7.9.2).

Table 7.9.2 Impact of Tariff Cuts on Household Incomes, Y_h

Household category	Base Income	Income (shocked)	% change
Central-rur-households	2,258,540	2,285,392	1.2
Central-urb- households	3,569,255	3,623,409	1.5
Eastern-rur-households	1,631,092	1,653,433	1.4
Eastern-urb-households	488,895	495,648	1.4
Northern-rur-households	811,467	822,816	1.4
Northern-urb- households	263,477	267,360	1.5
Western-rur-households	1,737,154	1,764,673	1.6
Western-urb-households	663,268	673,519	1.5

Source: Own Computations. CGE Model Results. Household Income in Millions of Uganda Shillings.

Urban household benefit more than their rural counterparts as a result of a 50 percent decrease in import tariffs. This can be explained by the fact that urban households are endowed with skilled labour and large businesses which fetch higher factor returns (Nganou, 2005). In fact, incomes of western, central, northern and eastern urban households increase by 1.6 percent, 1.5 percent, 1.5 percent, and 1.4 percent respectively. Similarly, incomes of western, northern, eastern, and central rural households increase by 1.6 percent, 1.4 percent, 1.4 percent and 1.2 percent respectively.

Our findings support earlier results which found that trade liberalisation improves the welfare of the rural and urban poor (Dorosh *et al.*, 2000). This is true because a decrease in the price of imports due to tariff cuts leads to a more efficient allocation of domestic resources by increasing the employment of unskilled and low skilled labour and increasing factor payments (Nganou, 2005).

7.9.3 Impact on Sectoral Job Creation

The decline in import tariffs was accompanied by the increase in real imports, QM_c and depreciation of the exchange rate, *EXR*. The depreciation of the exchange rate, *EXR* increases the quantity of real exports, QE_c. The demand for goods produced and sold domestically, QD_c increases due to import substitution. The reallocation of resources to increase production of goods and services for the domestic and export markets leads to an increase in demand for factors which increases employment. A total of 286,003 low skilled rural labour jobs, of which 135,852 jobs (47 percent of the total) are low skilled rural female jobs and 109,595 jobs (38 percent of the total) are low skilled rural male jobs (Table 7.9.3).

Table 7.9.3 Impact of Tariff Cuts on Total Employment of Low Skilled Labour

	Base	Shocked	Share in jobs created
Low Skilled -rur-male	3,403,842	109,595	38
Low Skilled - rur- female	4,045,634	135,852	47
Low Skilled- urb- male	527,275	15,763	6
Low Skilled-urb-female	542,754	24,793	9
Total	*8,519,505*	*286,003*	*100*

Source: Own Computations. CGE Model Results.

Table 7.9.4 Impact of Tariff Cuts on Sectoral Employment of Low Skilled Labour

Sector	Base values	Shock effect	Jobs created	Share in total jobs created
Agriculture	5,393,553	5,567,144	173,591	61
Mining	50,260	51,194	934	0
Food Processing	447,009	468,584	21,575	8
Manufacturing	158,919	157,422	-1,497	-1
Utilities	5,871	6,053	182	0
Construction	157,761	162,358	4,597	2
Trade Service	257,036	264,870	7,834	3
Transport	233,469	250,230	16,761	6
Health & Education	379,492	390,640	11,148	4
Other Services	1,436,135	1,487,012	50,877	18
Total Jobs created/share	*8,519,505*	8,805,508	*286,003*	*100*

Source: Own Computations. CGE Model Results. Jobs created measures as Number of Workers.

Fewer low skilled labour jobs are created in urban areas after the shock. Of the total number of jobs created, 24,793 jobs (9 percent) are for female workers and 15,673 jobs (6 percent) are for male workers. Thus, tariff cuts created more jobs for female workers than their male counterparts. Regarding the sectoral distribution of jobs created (Table 7.9.4), the highest share of jobs are created in Agriculture with 173,591 jobs (61percent of the total); followed by Other Service(s) with 50,877 jobs (18 percent); Food Processing with 21,575 jobs (7.5 percent); Transport with 16,671 jobs (5.9 percent); and Health and Education with 11,148 jobs (3.9 percent of the total jobs created). It is worth noting that Mining and Utility sectors had the least share of jobs, each creating 934 jobs (0.3 percent) and 182 jobs (0.1 percent) respectively. As a result of the shock, the Manufacturing sector lost 1,497 jobs (-0.5 percent of the total).

A decline in import tariffs leads to changes in within sector employment of high skilled labour but the net effect on employment is zero (Table 7.9.5). This is because high skilled labour is assumed to be fixed in this study. Within sector employment of high skilled labour is significant in Other Services (829 jobs), followed by Food Processing (231 jobs), and Transport (179 jobs). Sectors that lose jobs after the decline in import tariffs include: Manufacturing (-766 jobs), Health and Education (-443 jobs), Trade Service (-48 jobs), and Construction (-28 jobs).

Table 7.9.5 Impact of Tariff Cuts on Employment of High Skilled Labour

Sector	Total $QF_{f,a}$ (Base)	Total QF_f (Shocked)
Agriculture	38,651	53
Mining	8	0
Food Processing	14,149	231
Manufacturing	19,815	-766
Utilities	15,843	-10
Construction	36,977	-28
Trade Service	24,886	-48
Transport	4,657	179
Health & Education	320,708	-440
Other Services	260,801	829
Total Jobs created	*736,495*	*0*

Source: Own Computations. CGE Model Results. Employment: Number of Workers.

7.10 Experiment 3. A 40% Increase in Migrant Remittances (*REMIT_INCR*)

7.10.1 Impact on Real GDP at Factor and Market Prices

The simulation results presented in Table 7.10.1 suggest that an increase in the migrant remittances by 40 percent has a positive impact on real GDP. Overall, real GDP at factor cost and market prices increases by 0.7 percent respectively. The increase in real GDP at factor cost is due to an increase in factor incomes, Y_f . Factor incomes increase due to an increase employment, $QF_{f,a}$. The net effect is an increase in real sectoral value added, QVA_a and real GDP at factor cost. An increase in factor incomes Y_f increases household incomes, Y_h which leads to an increase in demand for goods and services i.e. domestic goods QD_c and imports, QM_c.

Table 7.10.1 Impact of Increased Migrant Remittances on Real GDP

	Factor Income (base)	Factor Income (shocked)	% change
Low skilled-rur-male	580,834	585,358	0.78
Low skilled-rur-female	99,249	99,996	0.75
Low skilled-urb-male	192,656	193,386	0.38
Low skilled -urb-female	75,164	74,614	-0.73
High skilled-rur-male	718,471	725,293	0.95
High skilled-rur-female	244,233	246,219	0.81
High skilled-urb-male	1,052,894	1,058,100	0.49
High skilled-urb-female	426,968	430,469	0.82
Capital	6,671,989	6,715,636	0.65
Total Factor Income/value added	*10,062,459*	*10,129,070*	*0.70*
Real GDP at factor cost	*10,062,459*	*10,129,070*	*0.70*
Real GDP at Market Price	*10,911,520*	*10,983,960*	*0.70*

Source: Own Computations. CGE Model Results. Factor Incomes in Millions of Uganda Shillings.

The effect of migrant remittances on sectoral value added and price of value added (unit gross revenue) is presented in Table 7.10.2 below.

Table 7.10.2 Impact of Migrant Remittances on Sectoral Value Added

	PVA_a base	PVA_a shocked	% change	QVA_a base	QVA_a shocked	% change
Agriculture	0.75	0.752	0.33	2,692,669	2,704,998	0.5
Mining	0.69	0.68	-1.14	34,013	33,436	-1.7
Food Processing	0.15	0.15	-0.39	315,700	311,851	-1.2
Manufacturing	0.075	0.08	0.38	113,004	108,713	-3.8
Utilities	0.79	0.80	1.26	389,831	395,634	1.5
Construction	0.58	0.59	1.19	1,166,230	1,182,001	1.4
Trade Service	0.64	0.65	1.41	1,186,435	1,207,984	1.8
Transport	0.62	0.61	-1.03	335,138	329,841	-1.6
Health and Education	0.61	0.62	0.91	1,007,824	1,026,831	1.9
Other Service (s)	0.57	0.57	0.43	2,821,614	2,827,780	0.2
Real GDP at factor cost				*10,062,459*	*10,129,070*	*0.7*

Source: Own Computations. CGE Model Results. Value added in Millions of Uganda Shillings.

The increase in sectoral value added following an increase in migrant remittances is led by Health and Education (1.9 percent), followed by Trade Services (1.8 percent), Utilities (1.5 percent), and Construction (1.4 percent). Sectors that experience an increase in their value added are intensive in low skilled labour. This is consistent with the fact that an increase in migrant remittances increases the availability and productivity of unskilled and low-skilled labour relative to sectors that are intensive in high skilled labour and capital (Taylor and Adelman, 1996). The decline in value added, QVA_a in some sectors is due to the decline in the price of value added, PVA_a or unit gross revenue after the shock and are intensive in high skilled labour and capital whose employment $QF_{f,a}$ is fixed in our simulations. The decline in value added is significant for Manufacturing (-3.8 percent), Mining (-1.7 percent), Transport (-1.6 percent) and Food Processing (-1.2 percent).

7.10.3 Impact on the Current Account Balance

The adjustment mechanism of the current account[37] is made possible through flexible exchange rates, EXR and fixed foreign savings, $FSAV$. However, since other variables of the current account are fixed, (i.e. import (PM_c) and export prices (PE_c), factor transfers to the rest of the world $TR_{r,f}$, transfers between domestic institutions and the rest of the world, $TR_{i,r}$), the only variables allowed to adjust to bring equilibrium on the current account are the quantity of exports (QE_c) and imports (QM_c). An increase in migrant remittances from the rest of the world requires a decrease in net exports, (i.e. the difference between the foreign currency value of imports, QM_c and exports, QE_c) to restore equilibrium on the current account. The increase in imports is provided for by the appreciation of the exchange rate. In fact our results suggest that real exports decrease by 9.6 percent while real imports increase by 1.3 percent following a 3.1 percent appreciation of the exchange rate. Table 7.10.3 and Table 7.10.4 summarises the changes in real imports and exports following a 40 percent increase in migrant remittances, an appreciation of the exchange rate, and the decrease in import and export prices.

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[37] $$\sum_{c \in C} pwm_c \, QM_c + \sum_{i \in ID} TR_{r,i} / EXR + \sum_{f \in F} Y_{r,f} / EXR = \sum_{c \in C} pwe_c \, QE_c + \sum_{i \in ID} TR_{i,r} + \overline{FSAV}$$

Table 7.10.3 Impact of Migrant Remittances on Imports

Commodity	PM_c *base*	PM_c shocked	% change	QM_c base	QM_c shocked	% change
Agriculture	1	0.97	-3.1	96,152	106,529	10.8
Mining	1	0.97	-3.1	29,618	30,250	2.1
Processed Foods	1	0.97	-3.1	235,220	256,367	9.0
Manufacturing	1	0.97	-3.1	2,361,146	2,444,631	3.5
Transport	1	0.97	-3.1	388,694	406,695	4.6
Other Services	1	0.97	-3.1	224,730	241,045	7.3
Total Real Imports				2,950,080	2,969,369	1.33
Exchange Rate	*1*	*0.97*	*-3.1*			

Source: Own Computations. CGE Model Results. Real Imports in Millions of Uganda Shillings.

The increase in real imports, QM_c following a 40 percent increase in migrant remittance's, a 3.1 percent appreciation of the exchange rate, *EXR* and decline in import prices, PM_c is led by imports of agricultural goods (11percent), processed food products (9 percent), and other service goods (7 percent). On the other hand, the decrease in export prices and an appreciation of the exchange rate following the shock leads to a decrease in real exports, QE_c. The decline is real exports (Table 7.8.4) is led by Utilities (-11 percent), manufactured goods (-9.5 percent), processed food exports (-7 percent), trade services (-6.9 percent), and agricultural goods (-6.3 percent).

Table 7.10.4 Impact of an Increase in Migrant Remittances on Real Exports

Commodity	PE_c base	PE_c shocked	% Change	QE_c base	QE_c shocked	% Change
Agriculture	1	0.97	-3.1	293,230	274,761	-6.3
Mining	1	0.97	-3.1	10,285	10,015	-2.6
Food Processing	1	0.97	-3.1	447,599	416,307	-7.0
Manufacturing	1	0.97	-3.1	159,465	144,353	-9.5
Utilities	1	0.97	-3.1	27,144	24,195	-10.9
Trade Services	1	0.97	-3.1	118,719	110,556	-6.9
Transport	1	0.97	-3.1	88,428	84,669	-4.3
Other Services	1	0.97	-3.1	369,419	346,697	-6.2
Real Total Exports				*1,514,289*	*1,367,605*	*-9.7*

Source: Own Computations. CGE Model Results. Real Exports in Millions of Uganda Shillings.

To sustain an increase in real GDP at market price following a decrease in net exports (QE_c-QM_c), total domestic consumption[38] should increase. By definition, GDP at market prices using the expenditure approach is given as: $GDP = C+I+G+(QE_c-QM_c)$. Since investment, $QINV_c$ and government consumption expenditure, $QC_{c,g}$ are fixed, to increase real GDP, private consumption, $QC_{c,h}$

[38] Total absorption $= C+I+G$

increases. Our findings indicate that real private consumption increases by 2.7 percent to sustain an increase in real GDP at factor cost and market price by 0.7 percent respectively. Private consumption increases due to an increase in household incomes. Household incomes increase due to an increase in factor employment, $QF_{f,a}$ which increases factor incomes, Y_f.

7.10.5 Impact of Migrant Remittances on the Saving-Investment Balances

From the definition of the savings investment gap[39], investment $QINV_c$ and foreign savings $FSAV$ are fixed, and closing the investment-savings gap following the increase in private savings $DSAV_h$ and a decrease in government savings $DSAV_g$ (Table 7.10.5) would require the domestic demand price of investment goods PQ_c to increase (Table 7.10.6).

Table 7.10.5 Impact of Migrant Remittances on Domestic Savings, $DSAV_{ID}$

	Savings (Base)	Savings (shocked)	% Change
Central-rur-households	68,484	74,778	9.2
Central-urb- households	291,113	314,437	8.0
Eastern-rur-households	28,037	31,025	10.7
Eastern-urb-households	29,690	33,112	11.5
Northern-rur-households	5,594	6,175	10.4
Northern-urb- households	14,502	16,149	11.4
Western-Rural Households	30,581	33,113	8.3
Western-Urban Households	32,000	34,346	7.3
Government	537,969	492,094	-8.5

Source: Own Computations. CGE Model Results. Real Savings in Millions of Uganda Shillings.

The increase in the price paid by domestic demanders, PQ_c increases the domestic supply QQ_c of all commodities (Table 7.8.6). The increase in the quantity of goods supplied to the domestic market QQ_c is led by transport services (1.9 percent), followed by processed food products (1.6 percent), agricultural goods (1 percent) and manufactured goods (1 percent).

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[39] $PQ_C * \overline{QINV_C} = DSAV_{IDNG} + DSAV_G + EXR * \overline{FSAV}$

Table 7.10.6 Impact of Migrant Remittances on Quantity Supplied to Domestic Market, QQ_c

	PQ_c base	PQ_c (shocked)	% Change	QQ_c (base)	QQ_c (shocked)	% Change
Agriculture	1.02	1.03	0.53	3,096,590	3,128,744	1.04
Mining	1.03	1.01	-1.61	70,472	70,985	0.73
Food Processing	1.06	1.07	0.36	2,134,654	2,1684,33	1.58
Manufacturing	1.03	1.00	-2.49	3,756,474	3,794,942	1.02
Electr & Water	1.05	1.06	1.26	458,716	462,642	0.86
Construction	1.01	1.01	0.03	2,045,529	2,047,898	0.12
Trade Service	1.00	1.01	1.01	1,865,964	1,880,859	0.80
Transport	1.02	1.00	-1.77	955,690	974,090	1.93
Health & Educ	1.03	1.03	0.64	1,853,409	1,867,984	0.79
Other Service (s)	1.01	1.02	0.17	4,294,379	4,323,897	0.69

Source: Own Computations. CGE Model Results. Quantities in Millions of Uganda Shillings.

7.10.7 Impact on Domestic Output Sold Domestically, QD_c

The increase in migrant remittances led to an increase in real imports, QM_c. Because of the substitution assumed in the model, domestic consumers can substitute imports for locally goods produced and sold domestically, QD_c. The net effect is an increase in supply of domestically produced goods to meet the increased demand. The increase in demand for domestic goods leads to an increase in supply prices, PD_c (Table 7.10.7). The increase in quantity sold domestically of domestic output, QD_c is significant for utilities (0.86 percent), trade services (0.8 percent), health and education services (0.79 percent), agricultural goods (0.73 percent), and processed food products (0.68 percent). Quantity sold of mining and manufactured goods decreases partly because of substitution by imports of mining and manufactured goods.

Table 7.10.7 Impact of Migrant Remittances on Output Sold Domestically, QD_c

	PD_c (base)	PD_c (shocked)	% Change	QD_c base	QD_c shocked	% Change
Agriculture	1	1.006	0.65	3,000,438	3,022,394	0.73
Mining	1	0.995	-0.51	40,853	40,740	-0.28
Food Processing	1	1.008	0.80	1,899,435	1,912,411	0.68
Manufacturing	1	0.986	-1.39	1,395,328	1,350,832	-3.19
Utilities	1	1.013	1.26	458,716	462,642	0.86
Construction	1	1.01	0.03	2,045,529	2,047,898	0.12
Trade Service	1	1.01	1.00	1,865,964	1,880,859	0.80
Transport	1	0.992	-0.83	566,996	567,517	0.09
Health and Educ	1	1.006	0.64	1,853,409	1,867,984	0.79
Other Service (s)	1	1.004	0.350	4,069,649	4,083,111	0.33

Source: Own Computations. CGE Model Results. Quantities in Millions of Uganda Shillings.

7.11 Microeconomic Effects

7.11.1 Impact on Factor Incomes

The reallocation of resources to produce goods and services and import substitution to satisfy local demand following an increase in migrant remittances causes producers to demand for more factors of production which increases employment $QF_{f,a}$ and factor incomes, Y_f (Table 7.11.1) Increasing migrant remittances increases incomes and employment of rural based low skilled labour, most of whom are employed in agriculture.

Table 7.11.1 Impact of Migrant Remittances on Factor Incomes and Factor Demands, $QF_{f,a}$

Factor	Factor Income, Y_f (base)	Factor Income, Y_f (shocked)	% Change	$QF_{f,a}$ (base)	$QF_{f,a}$ (shocked)	% Change
Capital	6,671,989	6,715,636	0.65	6,671,988	6,671,988	0
High skilled-rur-male	718,471	725,293	0.95	353,158	353,158	0
High skilled-rur- female	244,233	246,219	0.81	177,366	177,366	0
High skilled -urb-male	1,052,894	1,058,100	0.49	127,725	127,725	0
High skilled-urb- female	426,968	430,469	0.82	78,246	78,246	0
Low skilled -rur- male	580,834	585,358	0.78	3,403,842	3,430,348	0.78
Low skilled - rur-female	99,249	99,996	0.75	4,045,634	4,076,101	0.75
Low skilled- urb-male	192,656	193,386	0.38	527,275	529,272	0.38
Low skilled-urb-female	75,164	74,614	-0.73	542,754	538,742	-0.73

Source: Own Computations. CGE Model Results. Income in Millions of Uganda Shillings.

7.11.2 Impact of Migrant Remittances on Household Incomes and Expenditures

The need to increase output in some sectors to satisfy the increasing demand for domestically produced goods and imports leads to an increase in demand for and employment of factors of production. The increase in factor employment, $QF_{f,a}$ and incomes increases household incomes, Y_h and expenditures, $EXPE_h$ (Table 7.11.2). Simulation results suggest that household incomes increase significantly across all household groups after the increase in workers remittances, *REMIT_INCR*. By region, the increase in income is more significant for households in the northern and eastern regions after the increase in migrant remittances.

Table 7.11.2 Impact of Migrant Remittances on Household Incomes and Total Expenditures

	$EXPE_h$ (base)	$EXPE_h$ (shocked)	% Change	Income, Y_h (base)	Income, Y_h (shocked)	% Change
Central-rur-households	2,170,576	2,228,533	2.7	2,258,540	2,323,347	2.9
Central-urb- households	1,984,724	2,013,140	1.4	3,569,255	3,632,011	1.8
Eastern-rur-households	1,590,353	1,656,199	4.1	1,631,092	1,700,466	4.3
Eastern-urb-households	306,818	324,275	5.7	488,895	513,676	5.1
Northern-rur-households	797,349	828,892	4.0	811,467	843,932	4.0
Northern-urb- households	141,253	148,772	5.3	263,477	276,413	4.9
Western-rur-households	1,680,815	1,712,742	1.9	1,737,154	1,772,130	2.0
Western-urb-households	319,797	322,980	1.0	663,268	670,672	1.1

Source: CGE Model Results. Expenditures and Incomes in Millions of Uganda Shillings.

The incomes of eastern and northern urban households increase by 5.1 percent and 4.9 percent respectively, while that of central and western urban households increase by 1.8 percent and 1.1 percent respectively. Similarly, the incomes of eastern and northern rural households increase by 4.3 percent and 4.9 percent compared to an increase of 2.9 percent and 2 percent for central and western rural households. The increase in income is higher for households in the northern and eastern region partly because these regions received nearly 50 percent[40] of all workers remittances in 2002. The increase in household incomes, Y_f is associated with an increase in total real household expenditures, $EXPE_h$. Expenditures of urban based households in the eastern and northern regions increased by 5.7 percent and 5.3 percent respectively. Urban based households in the central and western regions experienced a 1.4 percent and 1 percent increase in their expenditures. Compared to urban households, rural households spend less of their income following an increase in migrant remittances. Real expenditure of rural households in the central region increased by 2.7 percent compared to 1.9 percent increase for western rural households. For eastern rural households, their expenditures increase by 4.1 percent while expenditure by northern rural households increases by 4 percent after the shock to migrant remittances.

[40] See Chapter 4, Section 2.5. The 2002 Social Accounting Matrix for Uganda.

7.11.3 Impact of Migrant Remittances on Sectoral Employment

The reallocation of resources to increase production for the domestic market and import substitution increases demand for factors of production. The net effect is an increase in employment in those sectors with significant linkages to the domestic market. Approximately, 55,000 low skilled rural labour jobs are created, of which 30,467 jobs (55 percent of the total) are low skilled rural female jobs and 26,506 jobs (48 percent of the total) are low skilled rural male jobs (Table 7.11.3). More low skilled labour jobs are created in rural areas compared to urban areas, signifying the importance of migrant remittances to rural household welfare.

Regarding gender balance in employment, the shock to migrant remittances creates more employment for female workers than their male counterparts. Urban female workers lose out on employment following a shock to migrant remittances because there are largely employed in sectors intensive in high skilled labour (i.e. Mining, Food Processing, Manufacturing, and Transport sectors) whose employment is fixed in this study. In addition, job losses in these sectors could be attributed to import competition which reduces demand for labour in these sectors

Table 7.11.3 Impact of Migrant Remittances on Employment of Low Skilled Labour

Labour Type	Base employment	Jobs created	Share in jobs created
Low Skilled -rur-male	3,403,842	26,506	48%
Low Skilled - rur- female	4,045,634	30,467	55%
Low Skilled- urb- male	527,275	1,997	4%
Low Skilled-urb-female	542,754	-3,972	-7%
Total	*8,519,505*	*54,998*	*100%*

Source: Own Computations. CGE Model Results. Jobs Created: Number of Workers.

The sectoral distribution of low skilled labour jobs (Table 7.11.4) is as follows: Agriculture (with 42,528 jobs) takes the largest share (77 percent); followed by Health and Education with 10,674 or 19 percent of the total; Other Services with 9,344 jobs (17 percent); Trade Services with 8,355 jobs (15 percent); and Construction with 4,038 jobs (7 percent). The increase in migrant remittances caused job losses in some sectors. These include: Food Processing, Transport, and

Manufacturing lost 7,176 (-13 percent); 6,063 (-11 percent); 5,449 jobs (-10 percent) respectively. These sectors are intensive in high skilled labour whose employment is fixed. The increase in imports, QM_c after the shock could also explain the reduced demand for low skilled labour in these sectors.

Table 7.11.4 Impact of Migrant Remittances on Sectoral Employment of Low Skilled Labour

Sector	Base values	Shock effect	Jobs created	Share in Total Jobs Created
Agriculture	5,393,553	5,436,082	42,528	77%
Mining	50,260	48,844	-1,416	-3%
Food Processing	447,009	439,833	-7,176	-13%
Manufacturing	158,919	153,470	-5,449	-10%
Utilities	5,871	6,034	163	0.3%
Construction	157,761	161,799	4,038	7%
Trade Service	257,036	265,391	8,355	15%
Transport	233,469	202,395	-6,063	-11%
Health & Education	379,492	390,166	10,674	19%
Other Services	1,436,135	1,445,479	9,344	17%
Total Jobs created/share	*8,519,505*	8,549,493	*54,998*	*100*

Source: Own Computations. CGE Model Results.

7.12 Experiment 4: Effects of a 40% Increase in FDI in Uganda (*FSAV_INCR*)

Total investment is fixed in all simulations. Thus, an increase in FDI does not necessarily generate any additional investment in Uganda but replaces domestic funding for some existing projects. The effects of this simulation are transmitted into the Ugandan economy through exchange rate appreciation/depreciation and sectoral linkages. The effects of this simulation are presented below.

7.12.1 Impact on Real GDP and Current Account Balance

This experiment is equivalent to an injection of Uganda shillings 191,394 million into the socioeconomic system. The immediate effect of this injection is an increase in real GDP at factor and market price by 0.5 percent respectively. The increase in real GDP at factor cost is due to an increase in factor incomes, Y_f (Table 7.12.1). Factor incomes increase due to an increase in employment, $QF_{f,a}$. The net effect is an increase in real values added QVA_a of some sectors and real GDP at factor cost and market price.

Table 7.12.1 Impact of FDI on Real GDP at Factor Cost

	Factor Income, I_f (Base)	I_f (Shocked)	% Change
Low skilled-rur-male	580,834	582,165	0.2
Low skilled-rur-female	99,249	99,563	0.3
Low skilled-urb-male	192,656	193,534	0.5
Low skilled -urb-female	75,164	74,817	-0.5
High skilled-rur-male	718,471	724,805	0.9
High skilled-rur-female	244,233	246,151	0.8
High skilled-urb-male	1,052,894	1,058,679	0.5
High skilled-urb-female	426,968	430,279	0.8
Capital	6,671,989	6,705,118	0.5
Total Factor Income	*10,062,459*	*10,115,111*	*0.5*
Real GDP at Factor Cost	*10,062,459*	*10,115,110*	*0.5*
Real GDP at Market Price	*10,911,520*	*10,968,390*	*0.5*

Source: Own Computations. CGE Model Results. Incomes in Millions of Shillings.

An increase in foreign savings results in an exchange rate appreciation and a decline in the price of imports, PM_c. The decrease in import prices leads to an increase in demand for imported goods, QM_C. On the other hand, domestic buyers substitute imports for goods produced and sold domestically, QD_c. The increase in demand for domestic goods, QD_c leads to the increase in their supply price, PD_c. To increase the supply of goods in the domestic market, producers increase their demand for factors of production, $QF_{f,a}$ which in turn increases factor, Y_f and household incomes, Y_h. The value added, of some sectors, QVA_a increases as a result. The net effect is an increase in real value added by 0.5 percent (Table 7.12.2).

Table 7.12.2 Impact of an Increase in Foreign Savings on Sectoral Value Added

	PVA_a (base)	PVA_a (Shocked)	% Change	QVA_a (Base)	QVA_a (Shocked)	% Change
Agriculture	0.748	0.748	0.03	2,692,669	2,692,251	-0.02
Mining	0.691	0.685	-0.97	34,013	33,519	-1.45
Food Processing	0.154	0.154	-0.23	315,700	312,963	-0.87
Manufacturing	0.075	0.076	0.40	113,004	110,070	-2.60
Utilities	0.794	0.801	0.86	389,831	393,431	0.92
Construction	0.579	0.587	1.29	1,166,230	1,183,567	1.49
Trade Service	0.638	0.644	0.87	1,186,435	1,198,844	1.05
Transport	0.617	0.613	-0.69	335,138	331,451	-1.10
Health & Educ	0.611	0.616	0.85	1,007,824	1,023,945	1.60
Other Services	0.569	0.572	0.54	2,821,614	2,835,070	0.48
Value Added GDP				*10,062,459*	*10,115,111*	*0.52*

Source: Own Computations. CGE Model Results. Value added and GDP in Millions of Shillings

The increase in sectoral value added, QVA_a is led by Health and Education (1.6 percent), followed by Construction (1.5 percent), Trade Services (1.1 percent), and Utilities (1 percent). Activities that are intensive in high skilled labour and capital experience a decline in their value added because the employment of these factors is assumed to be fixed in this study. Making capital stock fully employed and not activity specific could have a positive impact on value added of these sectors. The results of the sensitivity analysis with fully employed capital as closure rule are presented in Table section 7.16.5.

Table 7.12.3 Impact of FDI on Price and Value of Output Produced and Sold Domestically, QD_c

	PD_c (base)	PD_c (Shocked)	% Change	QD_c (Base)	QD_c (Shocked)	% Change
Agriculture	1	1.002	0.25	3,000,438	3,018,405	0.60
Mining	1	0.995	-0.50	40,853	40,529	-0.79
Food Proc.	1	1.005	0.51	1,899,434	1,917,106	0.93
Manufacturing	1	0.990	-0.97	1,395,327	1,350,412	-3.22
Utilities	1	1.009	0.86	458,716	465,065	1.38
Construction	1	1.003	0.30	2,045,529	2,054,934	0.46
Trade Service	1	1.006	0.65	1,865,964	1,886,867	1.12
Transport	1	0.995	-0.55	566,996	564,309	-0.47
Health & Educ	1	1.006	0.61	1,853,409	1,876,371	1.24
Other Services	1	1.005	0.50	4,069,649	4,104,629	0.86

Source: Own Computations. CGE Model Results. Output Value in Millions of Shillings.

Table 7.12.3 suggests that increasing foreign savings in Uganda increases the domestic supply of utilities (1.4 percent), education and health services (1.2 percent), trade services (1.1 percent), processed food products (0.9 percent), other services (0.9 percent) and agricultural goods (0.6 percent). The domestic supply, QD_c of manufactured, mining goods and transport services declines by 3.2 percent, 0.8 percent, and 0.5 percent respectively. This could be explained partly by import competition following the appreciation of the exchange rate (Table 7.10.4).

7.12.4 Impact of Foreign Investment on the Current Account Balance

From the current account balance[41], the quantity of imports (QM_c) and exports, (QE_c) are the only variables allowed to adjust to clear the current account disequilibrium since foreign savings, $FSAV$ and transfers, TR are fixed. The increase in foreign savings, $FSAV$ causes exchange rate EXR appreciation. Exchange rate appreciation increases imports, QM_c and reduces exports, QE_c. Exports, QE_c decrease

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41 $$\sum_{c\in C} pwm_c\, QM_c + \sum_{i\in ID} TR_{r,i} / EXR + \sum_{f\in F} Y_{r,f} / EXR = \sum_{c\in C} pwe_c\, QE_c + \sum_{i\in ID} TR_{i,r} + \overline{FSAV}$$

because exchange rate appreciation makes them expensive to foreigners. The net effect is an increase in imports by 3 percent and a decrease in exports by 5 percent following a 2.2 percent appreciation of the exchange rate.

Table 7.12.4 Impact of Foreign Savings/Investment on Imports, QM_c

	PM_c Base	PM_c shocked	% Change	QM_c (Base)	QM_c (shocked)	% Change
Agriculture	1	0.978	-2.21	96,152	102,670	6.8
Mining	1	0.978	-2.21	29,618	29,996	1.3
Processed Foods	1	0.978	-2.21	235,220	249,549	6.1
Manufacturing	1	0.978	-2.21	2,361,146	2,421,241	2.5
Transport	1	0.978	-2.21	388,694	401,662	3.3
Other Services	1	0.978	-2.21	224,730	237,562	5.7
Total Real Imports				3,335,561	3,442,680	3.2
Exchange Rate	1	0.978	-2.21			

Source: Own Computations. CGE Model Results. Imports in Millions of Shillings.

The increase in imports is dominated by agricultural goods (6.8 percent), followed by processed food products (6.1percent), other services (5.7percent), transport (3.3percent), and manufactured goods (2.5 percent).

Table 7.12.5 Impact of Foreign Savings on Exports, QE_c

	PE_c (base)	PE_c (shocked)	% change	QE_c (base)	QE_c (shocked)	% change
Agriculture	1	0.978	-2.21	293,230	280,706	-4.3
Mining	1	0.978	-2.21	10,285	10,095	-1.9
Food Processing	1	0.978	-2.21	447,599	425,408	-5.0
Manufacturing	1	0.978	-2.21	159,465	148,513	-6.9
Utilities	1	0.978	-2.21	27,144	25,017	-7.8
Trade Services	1	0.978	-2.21	118,719	112,916	-4.9
Transport	1	0.978	-2.21	88,428	85,702	-3.1
Other Services	1	0.978	-2.21	369,419	351,998	-4.7
Real Total Exports				1,514,289	1,440,355	-4.9

Source: Own Computations. CGE model Results. Exports in Millions of Shillings.

Exchange rate appreciation leads to a decline in exports, QE_c (Table 7.12.5). With exchange rate appreciation, exports become expensive for foreigners and this consequently reduces their demand. The decline in exports is led by utilities (-7.8 percent), manufactured goods (-7 percent), processed food products (-5 percent), other services (-5 percent) and agriculture goods (-4.3percent).

7.12.6 Impact of Foreign Investment on the Savings-Investment Balance

Regarding the savings-investment balance, a decrease in private savings would require an increase in private consumption (Johansen, 1960). This implies that domestic final demand is reallocated from savings to private consumption and households allocate their pre-tax incomes, Y_h and savings, $DSAV_h$ to consumption and away from savings. Consequently, private savings decreases by 29.5 percent on average (Table 7.12.6). From the definition of the savings-investment balance[42], total investment and foreign savings are fixed, and closing the savings-investment gap following the decrease in private savings ($DSAV_{IDNG}$) and government savings ($DSAV_g$), would require the domestic demand price of investment goods and services, (PQ_c) to increase.

Table 7.12.6 Impact of Foreign Investment on Private and Public Savings

	Savings (base)	Savings (shocked)	% Change
Central-rur-households	68,484	48,487	-29.2
Central-urb- households	291,113	204,904	-29.6
Eastern-rur-households	28,037	19,773	-29.5
Eastern-urb-households	29,690	20,912	-29.6
Northern-rur-households	5,594	3,950	-29.4
Northern-urb- households	14,502	10,210	-29.6
Western-rur-households	30,581	21,537	-29.6
Western-urb-households	32,000	22,533	-29.6
Government	537,969	499,922	-7.1

Source: Own Computations. CGE model Results. Savings in Millions of Shillings.

Apart from Mining, Manufacturing, and Transport commodities whose demander price, PQ_c decreases, other commodities experience an increase in their demander prices, PQ_c following a 40 percent increase in foreign savings, $FSAV$ (Table 7.12.7). These include: Agriculture (0.1 percent), Food Processing (0.2 percent), Utilities (0.9 percent), Trade Services (0.7 percent), Education and Health (0.7 percent), and Other Services (0.3 percent).

Table 7.12.7 Impact of Foreign Savings on Demander Price and Supply

	PQ_c base	PQ_c shocked	% Change	QQ_c base	QQ_c Shocked	% Change
Agriculture	1.022	1.023	0.17	3,096,590	3,113,619	0.6
Mining	1.029	1.017	-1.22	70,472	70,725	0.4
Food Processing	1.061	1.063	0.21	2,134,654	2,156,706	1.0
Manufacturing	1.028	1.01	-1.76	3,756,474	3,784,562	0.7
Utilities	1.047	1.056	0.86	458,716	461,082	0.5
Construction	1.005	1.008	0.30	2,045,529	2,048,794	0.2
Trade Service	1.000	1.007	0.65	1,865,964	1,874,716	0.5
Transport	1.021	1.008	-1.23	955,690	969,021	1.4
Health & Education	1.026	1.033	0.61	1,853,409	1,864,930	0.6
Other Services	1.014	1.017	0.35	4,294,379	4,321,782	0.6

Source: Own Computations. CGE Model Results. Quantities in Millions of Shillings.

[42] $PQ_C * \overline{QINV_C} = DSAV_{IDNG} + DSAV_G + EXR * \overline{FSAV}$

The increase in demander prices, PQ_c leads to an increase in quantity of output supplied to the domestic market, QQ_c. The increase in supply is led by transport services (1.4 percent), followed by processed food products (1 percent), manufactured goods (0.7 percent), and agricultural goods (0.6 percent).

7.13 Microeconomic Effects

7.13.1 Impact of Foreign Investment on Factor Incomes and Employment

To satisfy the demand for domestically produced goods (QD_c) and imports (QM_c), the demand for factors (i.e. low skilled labour) increases. The employment of rural based female workers increases by 0.3 percent compared to 0.2 percent for rural based male workers (Table 7.13.1). Similarly, the demand for urban based male workers increases by 0.5 percent after the shock.

Table 7.13.1 Impact of Foreign Investment on Total Factor Demands, $QF_{f,a}$

Factor	Factor Income, Y_f (Base)	Factor Income Y_f (Shocked)	% Change	$QF_{f,a}$ Base	$QF_{f,a}$ Shocked	% Change
Capital	580,834	582,165	0.2	6,671,988	6,671,988	0
High skilled-rur-male	99,249	99,563	0.3	353,158	353,158	0
High skilled-rur- female	192,656	193,534	0.5	177,366	177,366	0
High skilled -urb-male	75,164	74,817	-0.5	127,725	127,725	0
High skilled-urb- female	718,471	724,805	0.9	78,246	78,246	0
Low skilled -rur- male	244,233	246,151	0.8	3,403,842	3,471,919	0.2
Low skilled - rur-female	1,052,894	1,058,679	0.5	4,045,634	4,057,771	0.3
Low skilled- urb-male	426,968	430,279	0.8	527,275	529,911	0.5
Low skilled-urb-female	6,671,989	6,705,118	0.5	542,754	540,040	-0.5
Total/percentage change	10,062,459	10,115,111	0.5	15,927,988	16,008,124	0.5

Source: Own Computations. CGE Model Results.

The demand for urban based low skilled females decreases partly because some of them are employed in sectors intensive in high skilled labour and capital whose employment is fixed (i.e. mining, manufacturing, transport, and food processing). The decline in employment of urban based females is as follows: Mining (-2.4 percent), Manufacturing (-2.2 percent), Transport (-1.8 percent), and Food Processing (-1.1 percent).

The number of low skilled labour jobs created after the increase in foreign savings, *FSAV* (Table 7.13.2) is led by rural based female workers (62 percent), followed by rural males (38 percent), and low skilled urban males (12 percent).As noted earlier, the total employment of low skilled labour decreases (-12 percent).

Table 7.13.2 Impact of Foreign Savings on Total Employment of Low Skilled Labour

Labour Category	Employment (Base)	*Total Jobs Created*	Share in Jobs Created
Low Skilled, Rural Male	3,403,842	7,799	38%
Low Skilled, Rural Female	4,045,634	12,805	62%
Low Skilled, Urban Male	527,275	2,402	12%
Low Skilled Urban Female	542,754	-2,509	-12%
Total Jobs created	*8,519,505*	*20,497*	*100*

Source: Own Computations. CGE Model Results.

The distribution of sectoral employment of low skilled labour (Table 7.13.3) is led by other services (71 percent), followed by Health and Education services (46 percent), Trade Services (24 percent), and construction (21.5 percent).

Table 7.13.3 Impact of Increased Foreign Savings on Employment of Low Skilled Labour

Sector	Base Employment	Total Jobs Created	Share in Total Employment
Agriculture	5,393,553	835	4.1
Mining	50,260	-1,213	-5.9
Food Processing	447,009	-4,889	-23.9
Manufacturing	158,919	-3,509	-17.1
Utilities	5,871	105	0.5
Construction	157,761	4,415	21.5
Trade Service	257,036	4,949	24.1
Transport	233,469	-4,164	-20.3
Health & Education	379,492	9,339	45.6
Other Services	1,436,135	14,629	71.4
Total Employment	*8,519,505*	*20,497*	*100*

Source: Own Computations. CGE Model Results.

Increasing foreign savings or direct investment in Uganda has a negative impact on employment of low skilled labour. The total number of low skilled jobs lost is highest in food processing (-24 percent of the total), followed by transport services (-20.3 percent), and manufacturing (-17 percent). These sectors are intensive in high skilled labour whose employment is fixed.

7.14 Impact of Increased Foreign Savings on Household Incomes

The increase in demand for domestically produced goods, QD_c leads to increased employment of factors, $QF_{f,a}$ which increases household incomes, Y_h. Increasing foreign savings increases the employment of low skilled labour. The net effect is an increase in household incomes, Y_h (Table 7.14.1).

Table 7.14.1 Impact of Foreign Savings on Household Incomes, Y_h

Household Type	Income, Y_h (base)	Income, Y_h (shocked)	% Change
Central-rur-households	2,258,540	2,279,514	0.9
Central-urb- households	3,569,255	3,581,317	0.3
Eastern-rur-households	1,631,092	1,639,861	0.5
Eastern-urb-households	488,895	490,884	0.4
Northern-rur-households	811,467	816,851	0.7
Northern-urb- households	263,477	264,418	0.4
Western-rur-households	1,737,154	1,744,015	0.4
Western-urb-households	663,268	665,796	0.4

Source: Own computations: CGE Model Results. Incomes in Millions of Shillings.

Increasing foreign savings/investment in Uganda increases household incomes. The increase in income is dominated by rural based households because of their ownership of low skilled labour whose employment increases after the shock. The increase in income is highest for rural households in the central region (0.9 percent), followed by northern rural households (0.7 percent), and eastern rural households (0.5 percent). The incomes of households resident in urban areas increase by 0.4 percent in all regions, slightly below the increase in income for urban based households. Increased employment of rural based low skilled labour after the shock is partly responsible for increased household incomes in rural areas.

7.15 Impact of Foreign Savings on Total Household Expenditure, $EXPE_h$

Household expenditure, $EXPE_h$ is the difference between after tax income and savings, transfers between domestic institutions and to the rest of the world**.** The increase in foreign savings increases household incomes and this in turn increases total household expenditures (Table 7.15.1). Our findings suggest that expenditure, $EXPE_h$ of urban based households is higher than the expenditure of rural based households. Compared to rural households, urban households spend more on imports, QM_c which are now cheaper following a foreign exchange appreciation. The consumption basket of rural households is mainly dominated by agriculture and other domestically produced goods. They spend less or none of their after tax income on imports (Mbabazi *et al*., 2009).

Table 7.15.1 Impact of Foreign Investment on Household Expenditures, $EXPE_h$

Household Type	Expenditure, Base	Expenditure, Shocked	% Change
Central-rur-households	2,170,576	2,211,353	1.9
Central-urb- households	1,984,724	2,058,080	3.7
Eastern-rur-households	1,590,353	1,607,314	1.1
Eastern-urb-households	306,818	315,698	2.9
Northern-rur-households	797,349	804,319	0.9
Northern-urb- households	141,253	144,789	2.5
Western-rur-households	1,680,815	1,696,607	0.9
Western-urb-households	319,797	327,401	2.4

Source: Own Computations. CGE Model Results. Expenditure in Millions of Uganda Shillings

The increase in expenditure for urban households is dominated by households in the central region (3.7 percent), followed by Eastern region households (2.9 percent), Northern households (2.5 percent), and western region households (2.4 percent). Similarly, by region, expenditures of rural based households following the increase in foreign investment in Uganda is highest for central households (1.9 percent), followed by eastern households (1.1 percent), northern households (0.9 percent), and western households (0.9 percent).

7.16 Sensitivity Analysis: Alternate Trade Parameters and Factor Closure Rule

Simulation results based on the CGE modelling framework have always attracted significant criticism because most often these results are generated using parameters (i.e. trade parameters and Armington function elasticities) borrowed from other studies or countries and regions perceive to have similar characteristics as the one being studied. One explanation given in the literature for this situation is the lack of time series data especially in developing countries required to estimate such parameters and elasticities. To overcome the above problem, it is common practice to test the robustness of CGE Model simulation results by performing sensitivity analyses (De Maio, Stewart, and van der Hoeven, 1999). This is done by varying trade parameters (i.e. elasticities for the Armington function and transformation (CES and CET functions) and using alternate factor market closure (i.e. full employment vs. Unemployment). Since our trade parameters are borrowed from other SAM based CGE studies in developing economies, Uganda inclusive, we test the robustness of our results first by allowing a 50 percent increase and decrease of CES and CET elasticities and then performing the simulations again. The simulation results with original elasticities are compared with those performed using high and low elasticities. Secondly, all simulations are performed assuming the full employment closure (i.e. all factors are mobile and fully employed) and the results are compared with the base solution. Recall, all simulations were initially performed under the full employment closure for high skilled labour and capital, and the unemployment closure (i.e. flexible employment and fixed wages) for unskilled and low skilled labour.

The robustness of the simulation results and thus the sensitivity of the CGE model is confirmed in two ways: First, by computing the impact differential (i.e. the post shock difference between the percentage change in the value of the variable with original elasticities and the new elasticities or factor market closure) and; secondly, by checking for the direction of impact for each of the selected variables (Nganou, 2005). The smaller the impact differential, the more consistent is our CGE model. However, this dissertation adopts the preservation of signs (Table 7.16.2) to confirm the consistency of our CGE model and simulation results. The impact of simulations on selected variables under the old and new elasticities and factor market closures are presented in Tables 7.16.1 and Table 7.16.3 below.

Based on the direction of impact on selected macroeconomic variables and household income distribution generated by varying trade parameters, the findings presented below indicate that the signs were preserved across all simulations. In addition, the combination of the full employment and the unemployment closure rules for factor markets indicate that all signs are preserved and the resulting effects of simulations with the original and new parameters and factor market closure have identical signs and negligible impact differentials. Based on these findings, we can conclude that the CGE model used in this dissertation produces robust results and is therefore consistent.

Table 7.16.1 Sensitivity Test Results: Impact of Changing Trade Parameters on Selected Macroeconomic Variables (%)

	PWE_INCR	*TAR_CUT*	*REMIT_INCR*	*FSAV_INCR*
GDPFC (original)	9.00	1.82	0.66	0.52
GDPFC (high elasticities)	9.10	1.80	0.64	0.51
GDPFC (low elasticities	9.00	1.82	0.69	0.54
GDPMP (original elasticities)	7.70	1.20	0.72	0.52
GDPMP (high elasticities)	7.95	1.18	0.65	0.57
GPDMP (low elasticities)	7.54	1.15	0.68	0.54
Real Exchange Rate (original)	0.85 (-15.4)	1.02 (2.4)	0.97 (-3.10)	0.978 (-2.2)
Real Exchange Rate (high)	0.85 (-15.3)	1.02 (2.4)	0.97 (-3.00)	0.979 (-2.1)
Real Exchange Rate (low)	0.85(-15.4)	1.02 (2.4)	0.968 (-3.2)	0.977 (-2.3)
Real total exports (original)	35.5	7.40	-9.70	-6.99
Real total exports (high)	36.9	7.60	-9.66	-6.97
Real total exports (low)	34.0	7.25	-9.71	-7.01
Real total imports (original)	6.00	5.70	1.33	0.99
Real total imports (high)	6.78	5.80	1.44	1.07
Real total imports (low)	5.19	5.63	1.22	0.91
Total absorption (original)	3.60	0.33	1.15	0.65
Total absorption (high)	3.67	0.32	1.15	0.65
Total absorption (low)	3.57	0.34	1.15	0.65
Private savings (original)	24.3	13.39	7.50	-15.8
Private savings (high)	23.9	13.44	7.24	-16.0
Private savings (low)	24.7	15.40	7.69	-15.7
Government savings (original)	-39.2	-32.8	-8.53	-7.10
Government savings (high)	-39.1	-32.9	-8.22	-7.10
Government savings (low)	-39.2	-32.7	-8.86	-7.30

Table 7.16.2 Trade Parameter Sensitivity Test: Direction of Impact on Economic Variables

	PWE_INCR	*TAR_CUT*	*REMIT_INCR*	*FSAV_INCR*
GDPFC (original elasticities)	+	+	+	+
GDPFC (high elasticities)	+	+	+	+
GDPFC (low elasticities)	+	+	+	+
GDPMP (original)	+	+	+	+
GDPMP (high)	+	+	+	+
GPDMP (low)	+	+	+	+
Real Exchange Rate (original)	-	+	-	-
Real Exchange Rate (high)	-	+	-	-
Real Exchange Rate (low)	-	+	-	-
Real exports (original)	+	+	-	-
Real exports (high)	+	+	-	-
Real exports (low)	+	+	-	-
Real imports (original)	+	+	+	+
Real imports (high)	+	+	+	+
Real imports (low)	+	+	+	+
Total absorption (original)	+	+	+	+
Total absorption (high)	+	+	+	+
Total absorption (low)	+	+	+	+
Real private savings (original)	+	+	+	-
Real private savings (high)	+	+	+	-
Real private savings (low)	+	+	+	-
Government savings (original)	-	-	-	-
Government savings (high)	-	-	-	-
Government savings (low)	-	-	-	-

Source: CGE model Simulations performed with old and new elasiticities. High and low trade parameters are equivalent to a 50 percent increase and decrease of base case or original elasticities respectively. *PWE_INCR*: 30% increase in the world price of exports; *TAR_CUT*: 50% decrease in import taxes; *REMIT_INCR*: 40% increase in workers remittances; *FSAV_INCR*: 40% increase in foreign savings/foreign direct investment. GDPFC: Real GDP at factor cost; GDPMP: Real GDP at market price (spending side). Exchange rate is local currency per unit of foreign currency.

Table 7.16.3 Sensitivity Test with Alternate Factor Market Closure Rule: Selected Variables (%)

	PWE_INCR	*TAR_CUT*	*REMIT_INCR*	*FSAV_INCR*
GDPFC (unemploy’t & full employ’t)	9.00	1.82	0.66	0.52
GDPFC (fully employment)	9.12	1.85	0.59	0.40
GDPMP (unemploy’nt & full employ’nt)	7.74	0.04	0.72	0.52
GDPMP (full employment)	7.90	0.07	0.70	0.50
Real Exchange Rate (unemploy’t & full employ’t	0.847 (-15.3)	1.02 (2.4)	0.97(-3.0)	0.978 (-2.2)
Real Exchange Rate (full employment)	0.848 (-15.2)	1.02 (2.3)	0.97(-3.0)	0.979 (-2.1)
Real Total exports (unemploy’t & full employ’t)	35.5	7.4	-12.	-7.0
Real Total exports (full employment)	36.2	6.8	-9.6	-7.0
Real imports (unemploy’t & full employ’t)	6.0	5.7	1.7	1.0
Real imports (full employment)	6.5	5.4	1.5	1.1
Total absorption (unemploy’t & full employ’t)	3.6	0.3	1.2	0.7
Total absorption (full employment)	3.8	0.3	0.9	0.6
Private savings (unemploy’t & full employ’t)	24.3	13.4	7.5	-15.8
Private savings (full employment)	24.1	16.2	5.1	-17.4
Government savings (unemploy’t & full employ’t)	-39.0	-32.8	-10.6	-7.1
Government savings (full employ’t)	-38.0	-33.4	-8.1	-6.2

Source: CGE Model Results. *PWE_INCR*: 30% increase in the world price of exports; *TAR_CUT*: 50% decrease in import taxes; *REMIT_INCR*: 40% increase in workers remittances; *FSAV_INCR*: 40% increase in foreign savings/foreign direct investment. GDPFC: Real GDP at factor cost; GDPMP: Real GDP at market price (spending side). Exchange rate is local currency per unit of foreign currency. Figures in parenthesis indicate percentage change depreciation or appreciation of exchange rate. Full employment: High skilled labour and capital are mobile and fully employed.

Table 7.16.4 Sensitivity Test with Alternate Factor Market Closure Rule: Direction of Impact

	PWE_INCR	*TAR_CUT*	*REMIT_INCR*	*FSAV_INCR*
GDPFC (unemploy’t & full employ’t)	+	+	+	+
GDPFC (fully employment)	+	+	+	+
GDPMP (unemploy’nt & full employ’nt)	+	+	+	+
GDPMP (full employment)	+	+	+	+
Real Exchange Rate (unemploy’t & full employ’t	-	+	-	-
Real Exchange Rate (full employment)	-	+	-	-
Real Total exports (unemploy’t & full employ’t)	+	+	-	-
Real Total exports (full employment)	+	+	-	-
Real imports (unemploy’t & full employ’t)	+	+	+	+
Real imports (full employment)	+	+	+	+
Total absorption (unemploy’t & full employ’t)	+	+	+	+
Total absorption (full employment)	+	+	+	+
Private savings (unemploy’t & full employ’t)	+	+	+	-
Private savings (full employment)	+	+	+	-
Government savings (unemploy’t & full employ’t)	-	-	-	-
Government savings (unemploy’t & full employ’t)	-	-	-	-

Source: CGE model Simulations performed with old and new elasticities. *PWE_INCR*: 30% increase in the world price of exports; *TAR_CUT*: 50% decrease in import taxes; *REMIT_INCR*: 40% increase in workers remittances; *FSAV_INCR*: 40% increase in foreign savings/foreign direct investment. GDPFC: Real GDP at factor cost; GDPMP: Real GDP at market price (spending side). Exchange rate is local currency per unit of foreign currency. Full employment: High Skilled Labour and Capital are Fully Employed and Mobile.

Table 7.16.5 Impact of Simulations on Sectoral Value Added When Capital is Mobile and Fully Employed

Sector	Base QVA_a	*PWE _INCR*	*% Change*	*TAR_CUT*	*% Change*	*REMIT _INCR*	*% Change*	*FSAV _INCR*	% Change
AGRI	2,692,669	2,692,695	9.4	2,744,254	1.9	2,705,834	0.5	2,692,695	0.0
MIN	34,013	33,679	5.3	34,429	1.2	33,628	-1.1	33,679	-1.0
PROC	315,700	314,053	15.2	324,091	2.7	313,977	-0.5	314,053	-0.5
MAN	113,004	110,180	6.0	110,878	-1.9	108,932	-3.6	110,180	-2.5
ELEC	389,831	393,211	9.3	395,964	1.6	395,158	1.4	393,211	0.9
CONS	1,166,230	1,173,311	8.5	1,186,465	1.7	1,174,782	0.7	1,173,311	0.6
TRS	1,186,435	1,195,889	11.3	1,206,638	1.7	1,202,671	1.4	1,195,889	0.8
TRAN	335,138	332,067	2.0	348,531	4.0	330,599	-1.4	332,067	-0.9
HEAL	1,007,824	1,022,124	9.1	1,022,795	1.5	1,025,589	1.8	1,022,124	1.4
OTH	2,821,614	2,835,715	8.5	2,874,845	1.9	2,831,010	0.3	2,835,715	0.5
Total	*10,062,459*	*10,102,924*		*10,248,891*		*10,122,180*		*10,102,924*	

Source: CGE model Simulations. *PWE_INCR*: 30% increase in the world price of exports; *TAR_CUT*: 50% decrease in import taxes; *REMIT_INCR*: 40% increase in workers remittances; *FSAV_INCR*: 40% increase in foreign savings/foreign direct investment. Full employment: High Skilled Labour and Capital are Fully Employed and Mobile.

Table 7.16.6 Impact of Simulations on Sectoral Value Added: Capital is Activity Specific and Fully Employed

Sector	*Base values*	*PWE_INCR*	*% Change*	*TAR_CUT*	*% Change*	*REMIT_INCR*	*% Change*	*FSAV_INCR*	*% Change*
AGRIC	2,692,669	2,933,588	8.9	2,744,305	1.92	2,704,998	0.5	2,692,251	-0.02
MIN	34,013	35,469	4.3	34,390	1.11	33,436	-1.7	33,519	-1.45
PROC	315,700	369,961	17.5	325,277	3.03	311,851	-1.2	312,963	-0.87
MAN	113,004	118,845	5.6	110,894	-1.87	108,713	-3.8	110,070	-2.6
UTIL	389,831	425,408	9.1	395,825	1.54	395,634	1.5	393,431	0.92
CONS	1,166,230	1,262,576	8.3	1,183,582	1.49	1,182,001	1.4	1,183,567	1.49
TRS	1,186,435	1,332,429	12.3	1,205,098	1.57	1,207,984	1.8	1,198,844	1.05
TRAN	335,138	342,558	2.2	348,653	4.03	329,841	-1.6	331,451	-1.1
HEAL	1,007,824	1,098,614	9	1,022,285	1.43	1,026,831	1.9	1,023,945	1.6
OTH	2,821,614	3,054,568	8.3	2,875,112	1.9	2,827,780	0.2	2,835,070	0.48
Total	*10,062,459*	*10,974,014*		*10,245,420*		*10,129,069*		*10,115,111*	

Source: CGE model Simulations. *PWE_INCR*: 30% increase in the world price of exports; *TAR_CUT*: 50% decrease in import taxes; *REMIT_INCR*: 40% increase in workers remittances; *FSAV_INCR*: 40% increase in foreign savings/foreign direct investment. Full employment: High Skilled Labour and Capital are Fully Employed and Mobile.

7.17 Conclusion

This chapter intended to discuss the design of the simulations that were performed in the CGE model for Uganda.

In addition, the effects of selected exogenous changes and policy shocks on the socioeconomic system are explained. Results for each simulation were explained using a set of factor and macro closures which were selected based on their relevancy to Uganda's economy and their economy wide use in SAM based CGE studies in developing countries. Each simulation produces results that are discussed at the macro level (i.e. government and foreign sector accounts) and at the micro level (i.e. impact on household welfare and factor employment). Compared to the CGE model, the results of the SAM multiplier model appear overestimated. This is mainly attributed to the limiting assumptions of the SAM multiplier model (i.e. no factor substitution, constant prices, and linearity of the production functions). Finally, the quality and robustness of the model results was confirmed by the use of sensitivity tests (i.e. by varying parameters for the CES and CET functions, and alternate factor market closures. The impact of simulations on welfare and inequality are discussed in the next chapter.

Chapter 8

Impact of Simulations on Welfare and Inequality Measures

8.1 Introduction

This chapter is intended to achieve three objectives namely: the construction of inequality indices using standard inequality measurements; the use of the computed inequality indices to analyse the impact of exogenous changes and policies on household welfare; and to measure the welfare effects of these policies for different household groups using the equivalent variation (EV) and compensating variation (CV) welfare measures. It is worth mentioning that the results of this analysis will provide the basis for answering one of the key research questions of this dissertation: what is the impact of exogenous policy changes on inequality and welfare of households, and which households are mostly affected by these policies? We hypothesize that exogenous changes and policies that increase real output, employment, factor and household incomes would directly or indirectly improve household welfare as (measured by the CV and EV techniques) and reduce inequality. These experiments are: a 30 percent increase in the world price of exports (*PWE_INCR*); a 50 percent decline in import tariffs (*TAR_CUT*); a 40 percent increase in migrant worker's remittances (*REMIT_INCR*); and a 40 percent increase in foreign savings or net borrowing from abroad by Uganda (*FSAV_INCR*).

Further, if policy makers are aware of the sources and causes of inequality, the households and regions that are mostly affected, and the policies that reduce inequality and increase welfare, then it is better to implement those policies and redirect resources to most vulnerable households and regions (i.e. those that do not benefit from policy interventions). For example, if an increase in world export prices increases agriculture exports and farm revenues in both rural and urban areas, the appropriate policies to reduce rural poverty and inequality would be to focus on increasing the productivity of the agriculture sector by providing farmers with free or subsidized inputs, training, high yield crops, providing access to credit facilities, and building adequate infrastructure (i.e. feeder roads and cooperatives) to help farmers access domestic and regional markets. On the other hand, if an increase in migrant workers remittances increases household incomes and reduces income inequality, the policy implication would be to provide an enabling environment to encourage Ugandans living and working abroad to invest locally and to allow for migration of surplus labour to neighboring regions if need arises. Migrant remittances have been found to play a significant role in alleviating poverty because such funds are directly received by households and are used to buy food, agriculture inputs and scholastic materials, investment in real estate, and to increase household savings (Migration and Remittances Fact Book, 2010/2011; Bank of Uganda Annual Reports, 2008/2009).

8.2 Measuring Inequality

Inequality can be defined in several ways. It can be defined as the dispersion of a distribution of income, consumption and other indicators of human welfare (Litchfield, 1999). For the purpose of this study, we will define inequality as a measure of the dispersion of household income distribution/expenditure. Several measures of inequality have been widely debated in the literature (Atkinson, 1983; Theil, 1979; Atkinson *et al*., 1989; Cowell, 1995; Bourguignon, 1979; and Duclos and Arrar, 2006). In fact, inequality has been analysed broadly and compared with other key concepts of poverty and welfare. However, inequality is a broader concept than poverty because it is defined over the entire population distribution and does not only focus on the poor (Haughton and Khandiker, 2009). Inequality can also be measured by analysing the top, middle and bottom distributions of income. In this dissertation, our emphasis is on computing inequality indices based on aggregate household incomes regardless of the nature of income distribution within household groups. Poverty, on the other hand deals with the partial distribution of persons or households living below a given poverty line (Litchfield, 1999). It is worth mentioning that there are various ways of measuring inequality. The easiest way to measure inequality is by dividing the population into quintiles from the poorest to the richest socioeconomic group and reporting the levels or percentage of any agreed measure of welfare such as income and expenditures accruing to each level. In this dissertation, our focus is limited to the discussion and presentation of results arising from commonly used inequality welfare measures. These include: the Gini coefficient; Generalised Entropy measures; and the Hoover inequality index. It should be noted that a good measure of inequality should satisfy the following conditions or axioms (Litchfield, 1999; Haughton and Khandiker, 2009).

(i) Mean independence: This condition implies that if all incomes were to be doubled, the resulting measure of inequality would not be affected.

(ii) Population size independence**:** Holding other factors constant, a change in population should not change the measure of inequality. Alternatively, merging two identical population distributions should not change the measure of inequality.

(iii) Symmetry: According to this condition, if two individuals were to exchange incomes, the measured inequality would remain unchanged.

(iv) Pigou-Dalton transfer sensitivity: According to this principle, the transfer of income from the rich to the poor should result into a decrease in inequality and vice versa (Atkinson, 1970; Cowell, 1985).

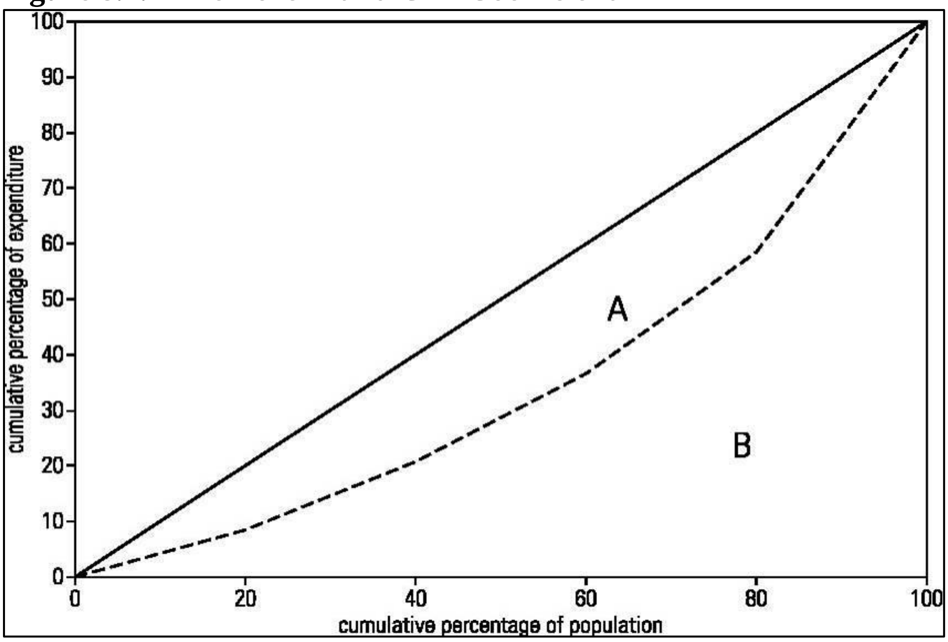
(v) Decomposability: A measure of inequality is said to be decomposable if overall inequality can be broken down by income sources or population sub-groups. Accordingly, if inequality increases among each sub-group or population, this might suggest an increase in overall inequality.

(vi) Statistical Testability: A good measure of inequality should be statistically tested for any significant changes over time. This used to be a problem in the past, but boot strap techniques are now used to generate confidence intervals for given inequality measures.

8.2.1 The Gini Coefficient of Inequality

This is one of the commonly used measures of inequality. The Lorenz curve, as cumulative frequency curve, forms the basis of the Gini coefficient. This curve compares the distribution of income, expenditure or any welfare variable with the uniform distribution that represents equality. The Gini coefficient is constructed by first ranking the cumulative percentage of households from the poor to the rich. The Lorenz curve (Figure 8.2.1) is then constructed by plotting the cumulative percentage of expenditure (or income) on the vertical axis and the cumulative percentage of population on the horizontal axis. The Gini coefficient is defined as the size of area A/(A+B), where A and B are the areas shown in Figure 8.2.1 below. The dotted line is the Lorenz curve and the diagonal line represents the line of perfect equality.

Figure 8.2.1 The Lorenz and Gini Coefficient



Source: The World Bank (2012). Measuring Inequality: Poverty Reduction and Equity Department Food and Agriculture Organization (FAO, 2005): Resources for Policy Making.

If the value of area A is zero, the Gini coefficient would be zero which is the case of perfect equality. On the other hand, if area B is equal to zero, the Gini coefficient would be 1, and this would imply perfect inequality. The larger the size of area A, the more unequal, the distribution of income. Generally, if X_i and Y_i are two points on the *X*-axis and *Y*-axis respectively, and the Lorenz curve can be approximated on each interval as a line between consecutive points, then the size of area B can be approximated with trapezoids as follows:

$$Gini = 1 - \sum_{i=1}^{n} \left(X_i - X_{i-1}\right)\left(Y_i + Y_{i-1}\right) \qquad \text{(ii)}$$

Sometimes the entire Lorenz curve is not known, and only values at certain intervals are given. In that case, the Gini coefficient can be approximated by using various techniques for interpolating the missing values of the Lorenz curve. If X_i, and Y_i are the known points on the Lorenz curve, with X_i indexed in increasing order, that is $X_{i-1} < X_i$, so that:

X_i = is the cumulated proportion of the population variable, for i = 0... n, with $X_0 = 0$, $X_n = 1$.

Y_i = is the cumulated proportion of the income variable, for i = 0, 1...n, with $Y_0 = 0$, and $Y_n = 1$.

Y_i should be indexed in non-decreasing order ($Y_i > Y_{i-1}$).

The Gini coefficient can be computed if the mean of a given distribution, the number of people or percentiles, and the income of each individual (or percentile) are known. Deaton (1979, pp.139) proposed the following formula for the Gini coefficient.

$$G = \frac{N+1}{N-1} - \frac{2}{N(N-1)u} \left(\sum_{i=1}^{n} P_i X_i\right) \qquad \text{(ii)}$$

u is mean income of the population, P_i is the income rank P of person i, with income X, such that the richest person receives a rank of 1 and the poorest a rank of N. This specification gives a higher weight to poorer people in the income distribution, which allows the Gini to satisfy the Pigou-Dalton Transfer Principle. The Deaton formulation rescales the coefficient so that its upper bound is always 1.

It should be noted that the intervals regarding the cumulative distribution of income and number of households) are generated from the data. Note that the households are disaggregated according to residence and geographical location and not by income class in the social accounting matrix used in this study. In addition, we do not calculate the Gini coefficient for each household group but we compare the calculated inequality and welfare indices with available Gini estimates for Uganda presented in Table 8.2.1 below.

Table 8.2.1 The Gini Coefficient for Uganda, 1992/1993-2009/2010

Region	1992/1993	2002/2003	2005/2006	2009/2010
National	0.365	0.428	0.408	0.426
Rural	0.328	0.363	0.363	0.375
Urban	0.396	0.483	0.432	0.447
Central	0.395	0.46	0.417	0.451
East	0.327	0.365	0.354	0.319
North	0.345	0.35	0.331	0.367
West	0.319	0.359	0.342	0.375

Source: Ssewanyana and Okidi (2007).

Note that the Gini coefficient satisfies the first four characteristics of a good measure of inequality mentioned above. In fact, the Gini coefficient cannot be decomposed to show the sources of inequality (i.e. inequality between different sub-groups or populations). In other words, the total Gini coefficient for sub-groups or populations is not equal to the Gini coefficient of the whole society. To enhance our analysis, we use those measures that satisfy all the characteristics of a good measure of inequality described in section 8.2. These inequality measures are collectively known as the Generalized Entropy (GE) inequality measures. The best known entropy measures are Theil-T and Theil-L, both of which enable us to decompose inequality into the part that is due to inequality within regions (for example, urban and rural inequality) and between areas (for example, the rural-urban income gap), as well as the sources of changes in inequality over time (within group inequality).

8.2.2 Hoover's Index of Inequality Measure (*HI*)

The Hoover inequality index measures the maximum vertical distance from the Lorenz curve to the 45^o line of equality (Kawachi and Kennedy, 1997). In other studies (Atkinson and Micklewright, 1992), this index has been referred as the Robin Hood index and is interpreted as the proportion of income that has to be transferred from those whose incomes are above the mean to those whose incomes are below the mean in order to obtain an equal distribution of income. The higher the value of the Hoover index, the higher the level of inequality. As such, a larger proportion of income above the mean must be transferred to those below the mean to obtain equality. Unlike the Atkinson and Generalised Entropy inequality indices, the Hoover index does not have a sensitivity parameter. The equation for the Hoover index satisfies

$$HI = \frac{1}{2}\sum_h \left| \frac{Y_h}{\sum_h Y_h} - \frac{N_h}{\sum_h N_h} \right| \tag{3}$$

N_h is the total number or population of each category of household group h distinguished by geographical location and gender).

8.2.3 Generalized Entropy Measures

The Theil-L (mean log deviation) and Theil-T inequality indices satisfy the criteria for a good measure of inequality. They both belong to the family of generalized entropy (GE) inequality measures. The general formula for these inequality measures is given by

$$GE(\alpha) = \frac{1}{\alpha(\alpha - 1)}\left[\frac{1}{N}\sum_{h=1}^{N}\left(\frac{Y_h}{\overline{\overline{Y}}_h} \right)^{\alpha} - 1 \right], \tag{4}$$

Y_h is the income of household group h; N is the total number or population of households; the parameter α represents the weight given to distances representing incomes at different parts of the income distribution, and can take on any real value. The values of generalized entropy measures vary between zero and infinity, with zero representing an equal distribution and higher values representing higher levels of inequality. In addition, the *GE* measures are more sensitive to the choice of the parameter α. The lower the value of α, the more sensitive GE is to the lower tail of the income distribution. For high values of α, *GE* is more sensitive to changes that affect the upper tail. In most studies, the parameter α may take on values of 0, 1, and 2 (Haughton and Khandiker, 2009). *GE*(0) and *GE*(1) are the Theil-L and Theil-T indices respectively. Their corresponding equations satisfy

$$GE(0) = \frac{1}{N}\sum_{h=1}^{N} ln\left(\frac{\overline{Y_h}}{Y_h}\right) \tag{5}$$

GE(0) is sometimes referred the mean log deviation measure.

$$GE(1) = \frac{1}{N}\sum_{h=1}^{N} \frac{Y_h}{\overline{\overline{Y_h}}} \ln\left(\frac{Y_h}{\overline{\overline{Y_h}}}\right) \tag{6}$$

The arithmetic average of the Theil-L and Theil-T inequality indices is referred to as the Theil-S index. When measuring inequality of income using the Generalized Entropy measures, the Theil-L index is associated with systems in which incomes are stochastically distributed to income earners and the Theil-T index is for those systems in which income earners are stochastically distributed to incomes. Unlike the Gini coefficient, Theil inequality indices have one setback. They do not have a close scale between 0 and 1 (Amartya Sen, 1996). However, this problem has been solved by normalizing the Theil indices (Dominguez- Dominguez and Nunez Velázquez, 2005).

8.3 Decomposition of Income Inequality

With availability of data, we can use the Theil-L, Theil-T and Hoover inequality indices to analyze the contributors to inequality by different sub-groups and based on regions, population, and income sources. To the extent that poverty tends to be concentrated in few socioeconomic groups, such as the landless and small farmers in rural areas, and the informal sector workers in urban areas, between group variance is likely to explain a reasonably high proportion of inequality in society (Thorbecke, 2000). Due to this reason, inequality measures are limited to inequality between urban and rural households residing in four regions namely: central, eastern, northern and western regions. In these regions, inequality might be explained by differences in age, education level, gender, employment status, and ownership of assets (between group components). On the other hand, for any household group or population classified by gender, age, education level, skilled and unskilled, rural and urban, and region, some inequalities might exist among households or people in the same sub-group (within group inequality). Due to data limitations and nature of disaggregation in the SAM used in this dissertation (i.e. households are not classified based on age, gender, employment status, etc.), our focus is on between group inequality i.e. between rural and urban households). Decomposing inequality is important for policy purposes. For example, if the cause of inequality is due to differences in asset ownership, then the appropriate policy should be to increase access to assets to those who are disadvantaged. On the other hand, if inequality is driven by inequalities within regions, then the government ought to prioritize development programs that benefit the poor in the affected areas.

As mentioned earlier, Generalized Entropy inequality measures satisfy the decomposition criterion of a good measure of inequality. In our analysis, we decompose the Theil-T and Theil-L indices by following the procedure in Deaton and Muellbauer (1980). Let Y_N represent the total income of the population, Y_h represent the income of the sub-group (household h), N is the total population (all household groups), and N_h is population of the sub-group (number of households in each sub group or region). Let *TT* represent the Theil-T index. Then

$$TT = \sum_{h=1}^{N} \frac{Y_h}{\sum_h N_h \sum_h Y_h} \ln\left(\frac{Y_h \sum_h N_h}{\sum_h Y_h \sum_h N_h} \right) \tag{7}$$

$$= \sum_{h=1}^{N} \frac{Y_h}{\sum_h Y_h} \ln\left(\frac{Y_h \sum_h N_h}{\sum_h Y_h} \right) \tag{8}$$

$$= \sum_h \left(\frac{Y_h}{\sum_h Y_h} \right) TT_h + \sum_h \frac{Y_h}{\sum_h Y_n} \ln\left(\frac{Y_h \big/ \sum_h Y_h}{N_h \big/ \sum_h N_h} \right) \tag{9}$$

Equation (9) suggests that we can decompose the Theil-T inequality index into two distinct components (i.e. within group and between groups inequality). Within group inequality index is represented by the left hand side of the equation. The right had side represent the between group inequality index. The Theil-L inequality index is decomposed as follows:

$$TL = \sum_{h=1}^{N} \frac{1}{\sum_h N_h} \ln\left(\frac{\sum_h Y_h}{Y_h \sum_h \sum_h N_h} \right) \tag{10}$$

By decomposing equation (10) further,

$$TL = \sum_h \left(\frac{N_h}{\sum_h N_h} \right) TL_h + \sum_h \frac{N_h}{\sum_h N_h} \ln\left(\frac{N_h \big/ \sum_h N_h}{Y_h \big/ \sum_h Y_h} \right) \tag{11}$$

The resulting Theil-T between group inequality index satisfies

$$TT = \sum_h \frac{Y_h}{\sum_h Y_n} \ln\left(\frac{Y_h \Big/ \sum_h Y_h}{N_h \Big/ \sum_h N_h} \right) \tag{12}$$

By simplifying further, the Theil-T between groups inequality index reduces to

$$TT = \ln\left(\frac{\sum_h N_h}{\sum_h Y_h} \right) - \frac{\sum_h Y_h \ln\left(N_h \big/ Y_h \right)}{\sum_h Y_h} \tag{13}$$

Similarly, the Theil-L index between groups inequality is written as

$$TL = \sum_h \frac{N_h}{\sum_h N_h} \ln\left(\frac{N_h \Big/ \sum_h N_h}{Y_h \Big/ \sum_h Y_h} \right) \tag{14}$$

Theil-L index for between groups inequality can be further expressed as

$$TL = \ln\left(\frac{\sum_h Y_h}{\sum_h N_h} \right) - \frac{\sum_h N_h \ln\left(Y_h \big/ N_h \right)}{\sum_h N_h} \tag{15}$$

The average of Theil-T and Theil-L indices (i.e. referred as the Theil-S index) is given by

$$TS = \frac{1}{2}\left(TT - TS \right) \tag{16}$$

Substituting equations (13) and (15) in equation (16) yields

$$TS = \frac{1}{2}\left[\ln\left(\frac{\sum_h N_h}{\sum_h Y_h} \right) - \frac{\sum_h Y_h \ln\left(N_h \big/ Y_h \right)}{\sum_h Y_h} + \ln\left(\frac{\sum_h Y_h}{\sum_h Y_h} \right) - \frac{\sum_h N_h \ln\left(Y_h \big/ N_h \right)}{\sum_h N_h} \right] \tag{17}$$

The between groups inequality index based on the Theil-S index is given by

$$TS = \frac{1}{2} \sum_h \ln\left(\frac{Y_h}{N_h} \right) \left(\frac{Y_h}{\sum_h Y_h} - \frac{N_h}{\sum_h N_h} \right) \tag{18}$$

8.4 Computing Inequality Indices with the CGE model for Uganda

Due to data limitations and the nature of household disaggregation in the social accounting matrix used in this dissertation, our model can only compute between groups inequality. The calculated values of the Theil-T, Theil-L, and Theil-S inequality indices are used for analysing the effects of exogenous changes on welfare and inequality in Uganda.

$$TT = \ln\left(\frac{\sum_h N_h}{\sum_h Y_h}\right) - \frac{\sum_h Y_h \ln\left(N_h \big/ Y_h\right)}{\sum_h Y_h} \tag{19}$$

$$TL = \ln\left(\frac{\sum_h Y_h}{\sum_h N_h}\right) - \frac{\sum_h N_h \ln\left(Y_h \big/ N_h\right)}{\sum_h N_h} \tag{20}$$

$$TS = \frac{1}{2}\sum_h \ln\left(\frac{Y_h}{N_h}\right)\left(\frac{Y_h}{\sum_h Y_h} - \frac{N_h}{\sum_h N_h}\right) \tag{21}$$

8.5 Measuring Welfare using the Inequality Indices

An economy may be evaluated using welfare functions. In most cases, these functions are a result of aggregated individual welfare approximated using household income which is normally adjusted by demographic and other economic factors (Gasparin and Walter, 2001). Atypical welfare function can be expressed as follows:

$$W = W\left(y_1, y_2, \ldots\ldots y_n\right) \tag{22}$$

where

W, y_i, and n represent welfare, income of sub-group, and population in the sub-group respectively. It is worth noting that the aggregation of any welfare function for evaluating an economy is not based on some perceived social mechanism but is entirely a choice of the policy maker. In this analysis, our goal is to use welfare functions to evaluate the impact of various exogenous policies on well-being, and to highlight the policy implications that might be relevant to address household and regional inequalities in Uganda. In some cases, abbreviated welfare functions can be restricted to two arguments namely, the mean and an inequality parameter as follows:

$$W = W(y_1, y_2, \ldots\ldots y_n) = V(\mu, I) \tag{23}$$

where

μ represents mean income and *I* is the inequality index, and n is the population in the sub-group (i.e. the population of a given household group, and y_i is the income of the sub-group. *V* is expected to be non-decreasing function of μ and an increasing function of *I*. In addition, *V* and *I* are restricted so that Pareto, symmetry and quasi-concavity properties are maintained (Lambert, 1993). There are infinite ways of expressing the welfare function in equation (23), but for this analysis, we will concentrate on the Gini coefficient (*G*), Theil inequality indices (*TL*, *TT*, *TS*) and the Hoover Index (*H*). The abbreviated welfare function corresponding to the Gini coefficient as proposed by Sen (1976) is given by

$$W_G = \left(\frac{\sum_h Y_h}{\sum_h N_h} \right) (1 - G) \tag{24}$$

and the welfare function due to the Hoover Index, *H* is given by

$$W_H = \left(\frac{\sum_h Y_h}{\sum_h N_h} \right) (1 - H) \tag{25}$$

The aggregated welfare functions based on the Theil-L and Theil-T index are those proposed by James Foster (1996). These functions satisfy the following equations.

$$W_{TL} = \left(\frac{\sum_h Y_h}{\sum_h N_h} \right) e^{-TL} \tag{26}$$

$$W_{TT}^{-1} = \left(\frac{\sum_h Y_h}{\sum_h N_h} \right) e^{TT} \tag{27}$$

8.6 Welfare Measurement using the Equivalent and Compensating Variations

Most CGE modelers use the compensating and equivalent variation techniques to analyse the welfare effects of given shocks or policies on a specific economy (Robichaud, 2001). Whereas it is quite easy to measure the impact of exogenous shocks on production and consumption levels, relative prices, and nominal income, and savings, it is not straight forward to determine quantitatively, how much better off or worse off households are after a given policy shock. The money metric utility functions can therefore be used to obtain monetary measures of the welfare effects of different exogenous changes and policies in Uganda. The most commonly used of these functions are the equivalent variation (EV) and compensating variation (CV).

The compensating variation (CV) is the amount of money or income that must be given to the household or individual to compensate him or her for a change in price (John Hicks, 1939). On the other hand, the Equivalent Variation (EV) is the amount of money that should be taken away from the household group or individual at the original price to make him or her just as worse off as the rise in the price does (Gravella and Rees, 1987).

Equivalent Variation captures the welfare change. This has strong micro-economic foundations and is the standard approach in CGE modelling work. It is essentially a measure of the change in income that is equivalent in its effect on utility to a change in the price of the commodity. That is, given the households' consumption bundle before the price increase, an evaluation is made of the amount that the government would need to take away from the household to reduce its welfare as much as the price increase does and vice versa for a price decrease. When we use EVs and CVs between households, it might be misleading as the utility received by each consumer or household group from a given amount of income differs. In our analysis, we use the semi-aggregated EVs and CVs based on the aggregation of a given class of households but not on individual or single household aggregation. The EV adjusts the total expenditure of the household at current prices (before the shock) so as to keep the household as well off before the shock and is thus a better measure of welfare changes than the compensating variation (Nganou, 2005). In our analysis, we express welfare measures (EV and CV) and the utility of each household group arising from each simulation as a percentage of GDP.

8.6.1 Calculating the EV and CV from Household's Utility Functions

In the CGE model for Uganda (Chapter 6 section 5.6), we expressed the total utility derived by each household *h* by a Cobb-Douglas utility function. This is again derived below for convenience. The objective of each household group is to maximize utility subject to his/her budget constraint.

$$UH_h = \prod_c \left(\frac{QC_{c,h}}{\beta_{c,h}} \right)^{\beta_{c,h}}, h \in IDNG, c \in C, \sum_c \beta_{c,h} = 1, \qquad (28)$$

where

$QC_{c,h}$ denotes consumption of commodity *c* by household h, the budget constraint is

$$EXPE_h = \sum_c PQ_c QC_{c,h}\ , \qquad (29)$$

and the resulting demand function for each household is given by

$$QC_{c,h} = \frac{\beta_{c,h} EXPE_h}{PQ_c}. \qquad (30)$$

where

$QC_{c,h}$ is quantity of commodity c consumed by household h; $\beta_{c,h}$ is the marginal share of consumption spending on commodity *c* by household h. Substituting equation (30) into equation (28) we obtain the real indirect utility function for household group h which satisfies

$$UH_h = \frac{EXPE_h}{CPIH_h} \tag{31}$$

where

$$CPIH_h = \prod_c PQ_c^{\beta_{c,h}} \tag{32}$$

is the consumer price index of household, *h*.

Using equation (31) and superscripts 0 and 1 to denote the pre-shock and post-shock situations respectively, the EV and CV are computed as follows. The CV adjusts the post-shock total expenditure so as to keep the household as well-off as before when a shock affects prices in the economy. Hence,

$\dfrac{EXPE_h^0}{CPIH_h^0} = \dfrac{EXPE_h^1 - CV_h}{CPIH_h^1}$, and we have

$$CV_h = EXPE_h^1 - \left(\frac{CPIH_h^1}{CPIH_h^0}\right) EXPE_h^0 \tag{33}$$

The EV adjusts the pre-shock total expenditure at current prices (before the shock) so as to keep the household as well-off as it would be in the post-shock situation. Hence, $\dfrac{EXPE_h^0 + EV_h}{CPIH_h^0} = \dfrac{EXPE_h^1}{CPIH_h^1}$, and we have

$$EV_h = \left(\frac{CPIH_h^0}{CPIH_h^1}\right) EXPE_h^1 - EXPE_h^0 \tag{34}$$

The cost of welfare to an a economy (*TEV & TCV*) due to exogenous policy changes that influence the price of commodities consumed by households is calculated by taking the arithmetic sum of the computed EVs and CVs and expressing it as a percentage of the post shock expenditure of all household groups under consideration. The resulting equations are given below.

$$TEV = 100\left[\frac{\sum_h EV_h}{\sum_h EXPE_h^1}\right] \tag{35}$$

$$TCV = 100\left[\frac{\sum_h CV_h}{\sum_h EXPE_h^1}\right] \tag{36}$$

where

TEV and *TCV* is the total cost of welfare due to the equivalent and compensating variation welfare measures respectively; and EXP_h^1 is the post shock expenditure of household *h*.

8.7 Impact of Simulations on Inequality and Welfare

8.7.1 Impact on Inequality Measures

The impact of simulation on inequality measures are presented in Table 8.7.1.

Table 8.7.1 Impact of Simulations on Inequality Measures

Inequality index	Theil-L	Theil-T	Theil-S	Hoover
Base values	0.156	0.174	0.165	0.242
PWE_INCR	0.158	0.176	0.167	0.243
% Change	0.940	0.980	0.96	0.34
TAR_CUT	0.157	0.174	0.165	0.243
% Change	0.140	0.00	0.00	0.140
REMIT_INCR	0.153	0.170	0.161	0.240
% Change	-2.30	-2.30	-2.30	-1.00
FSAV_INCR	0.156	0.173	0.165	0.24
% Change	0.000	-0.410	0.000	-0.30

Source: Own computations. CGE Model Results. *PWE_INCR*: 30% increase in the world price of exports; *TAR_CUT*: 50% decrease in import taxes; *REMIT_INCR*: 40% increase in workers remittances; *FSAV_INCR*: 40% increase in foreign savings/foreign direct investment.

Results in Table 8.7.1 reveal that simulation with the increase in workers remittances, *REMIT_INCR* is associated with the largest reduction in inequality measures compared to other simulations. The decrease in inequality measures following an increase in migrant remittances is between 1 percent and 2.3 percent. The increase in the world price of exports leads to an increase in inequality indices as measured by the Theil-L and Theil-T relative to their base values. The value of the Hoover Index is identical in all simulations. For all simulations, the value of the Hoover Index suggests that about 24 percent of the income of those above the mean must be transferred to those whose incomes are below the mean to obtain equality. Increasing migrant remittances, *REMIT_INCR* and foreign savings, *FSAV*, the Hoover index suggest that about 24 percent of the income of those households above the mean must be transferred to those whose incomes are below the mean to obtain equality respectively. It is worth noting that all simulations generated suggest lower inequality measures compared to the Gini coefficients presented in Table 8.1.1. Therefore, that the selected exogenous changes and policies have policy implications for reducing income inequality in Uganda. The percentage change in inequality is higher for the shock to world export price because the shock results in higher household incomes and expenditures compared to other simulations.

Apart from the increase in migrant remittances, the increase in aggregate inequality measures is consistent with the computed Gini coefficients which suggest that between inequality increased nationally, and regionally, and between rural and urban areas between 2002 and 2003. The increase in inequality measures arising from the increase in the world price of exports, *PWE_INCR* can be explained partly by an increase in real household expenditures in urban areas that offset the increase in incomes of rural and urban based households (See Tables 7.6.3 and 7.6.4).

8.8 Impact of Simulations on Welfare Measures

8.8.1 Impact of Simulations on Welfare Due to Theil and Hoover Inequality Indices

The results of simulations on welfare measures are presented in Table 8.8.1 and Figure 8.8.1 below.

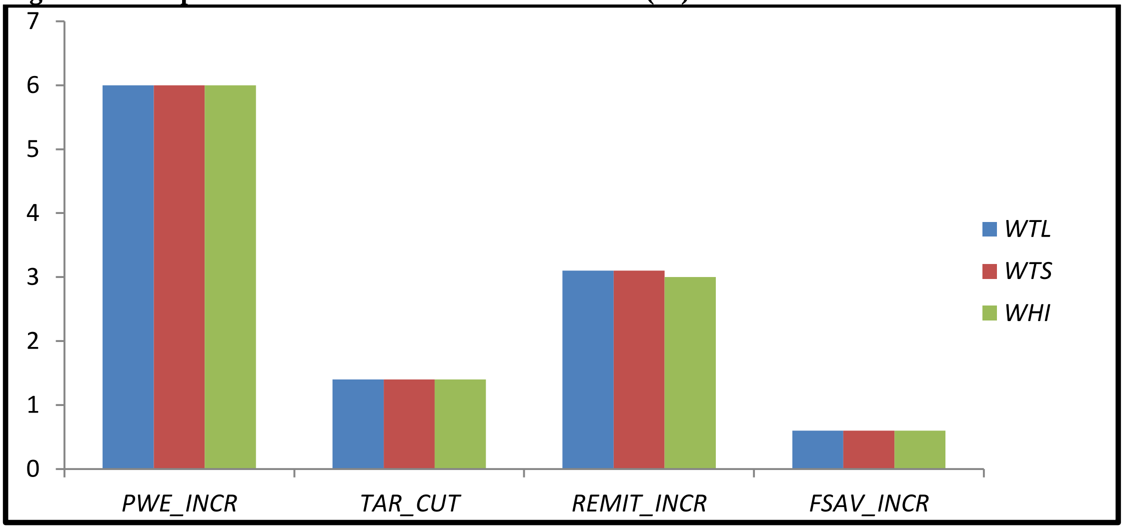
Table 8.8.1 Impact of Simulations on Welfare Measures (‘000 Uganda Shillings)

Welfare Measure	*WTL*	*WTS*	*WHI*
Base values	1,964,002	982,001	1,740,350
PWE_INCR	2,081,193	1,040,597	1,844,887
% Change	6	6	6
TAR_CUT	1,991,616	1,019,522	1,805,827
% Change	1.4	1.4	1.4
REMIT_INCR	2,024,337	1,012,169	1,792,969
%Change	3.1	3.1	3.0
FSAV_INCR	1,975,290	987,645	1,751,115
%Change	0.6	0.6	0.6

Source: Own computations. CGE Model Results. *PWE_INCR*: 30% increase in the world price of exports; *TAR_CUT*: 50% decrease in import taxes; *REMIT_INCR*: 40% increase in workers remittances; *FSAV_INCR*: 40% increase in foreign savings/foreign direct investment. *WTL* and *WTS*: Welfare measures due to Theil-L and Theil-S indices; *WHI*: Welfare measure due to the Hoover Index.

In general, aggregated welfare measures are higher with a 30 percent increase in world export price, relative to other simulations. Due to sectoral linkages, the increase in world export leads to relatively higher employment, output, and household incomes (Chapter 7, section 7.2). The increase in after tax household incomes increases household real consumption expenditures (i.e. welfare measures). The percentage change in welfare measures is illustrated by Figure 8.8.1. The change in welfare is higher for the shock to world export price, *PWE_INCR* (6 percent), followed by the increase in migrant remittances, *REMIT_INCR* (3.1 percent), tariff cuts, *TAR_CUT* (1.4 percent), and an increase in foreign savings, *FSAV_INCR* (0.6 percent).

Figure 8.8.1 Impact of Simulation on Welfare Measures (%)



Source: CGE Model Results. *PWE_INCR*: 30% increase in the world price of exports; *TAR_CUT*: 50% decrease in import taxes; *REMIT_INCR*: 40% increase in workers remittances; *FSAV_INCR*: 40% increase in foreign savings/foreign direct investment. *WTL* and *WTS*: Welfare measures due to Theil-L and Theil-S indices; *WHI*: Welfare measure due to the Hoover Index.

8.8.2 Impact of Simulations on EV & CV

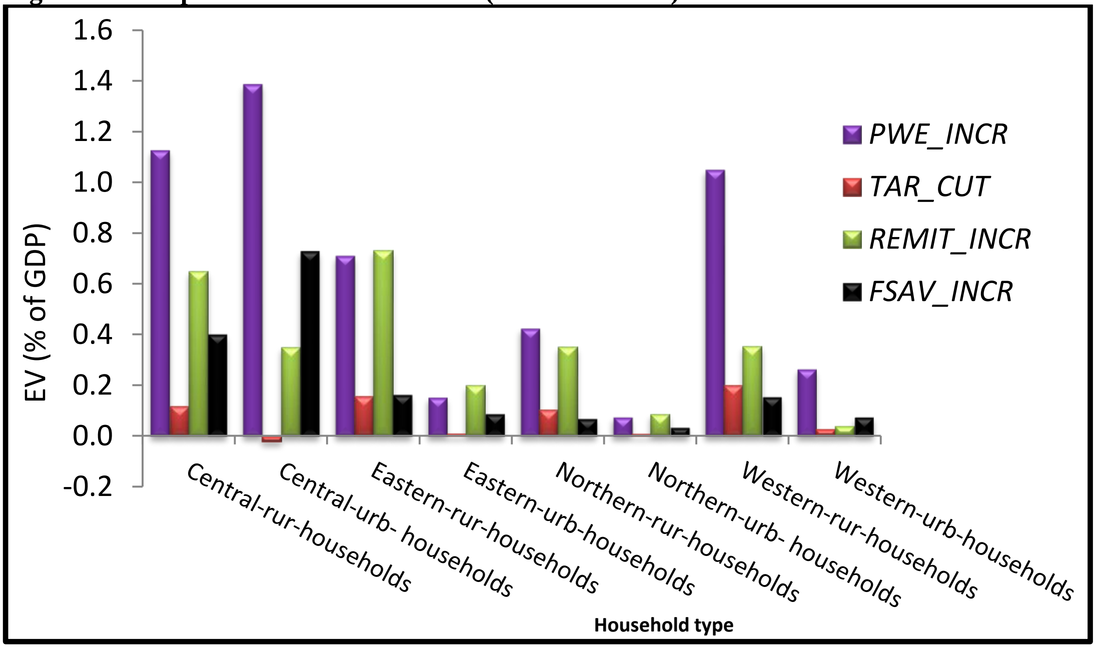
A more realistic measure of welfare is provided by the compensating and equivalent variation (CV& EV). The impact of simulations on EV and CV (i.e. in local currency units and as percentage of GDP) is presented in Tables 8.8.2 and Table 8.8.3, and Figures 8.8.2 and 8.8.3.

Table 8.8.2 Impact of Simulations on EV (Million Ug. Shillings)

Household	Base income	*PWE_INCR*	*TAR_CUT*	*REMIT_INCR*	*FSAV_INCR*
Central-rur-households	2,258,540	123,680	12,173	57,423	40,594
Central-urb- households	3,569,255	152,243	-2,218	30,741	73,653
Eastern-rur-households	1,631,092	78,102	16,137	64,830	16,643
Eastern-urb-households	488,895	16,943	1,052	17,771	9,020
Northern-rur-households	811,467	46,776	10,584	31,171	7,069
Northern-urb- households	264,655	8,411	910	7,666	3,616
Western-rur-households	1,775,138	115,224	20,584	31,252	15,754
Western-urb-households	663,268	29,143	2,763	3,479	7,704

Source: CGE Model Results. *PWE_INCR*: 30% increase in the world price of exports; *TAR_CUT*: 50% decrease in import taxes; *REMIT_INCR*: 40% increase in workers remittances; *FSAV_INCR*: 40% increase in foreign savings/foreign direct investment.

Figure 8.8.2 Impact of Simulations on EV (% of Real GDP)



Source: Own computations. CGE Model Results. *PWE_INCR*: 30% increase in the world price of exports; *TAR_CUT*: 50% decrease in import taxes; *REMIT_INCR*: 40% increase in workers remittances; *FSAV_INCR*: 40% increase in Foreign Savings/Foreign Direct Investment.

The simulation results presented in Table 8.8.2 suggest that an increase in the world price of exports (*PWE_INC*R) leads to an increase in expenditure based equivalent variation for all households groups. The increase in household incomes is due to the increase in factor employment by sectors with significant linkages to the export sector. The increase in equivalent variation as result of the increase in world export price is between 8 thousand million and 150 thousand million Uganda shillings respectively, and this is about 0.1 percent to 1.4 percent of GDP (Figure 8.8.2). An increase in migrant remittances, *REMIT_INCR* is associated with an increase in welfare with rural households in all regions taking between 3 thousand million and 64 thousand million shillings respectively and this account for about 0.1 percent to 0.7 percent of GDP (Figure 8.8.3). The decrease in the consumer price index of household groups, CPI_h and the increase in real household expenditures, $EXPE_h$ is partly responsible for the increase in household welfare. Eastern and central rural households experienced the highest CV and EV after the shock. This is because these households received the largest share of migrant remittances which increased their incomes and expenditure's (See Chapter 4).

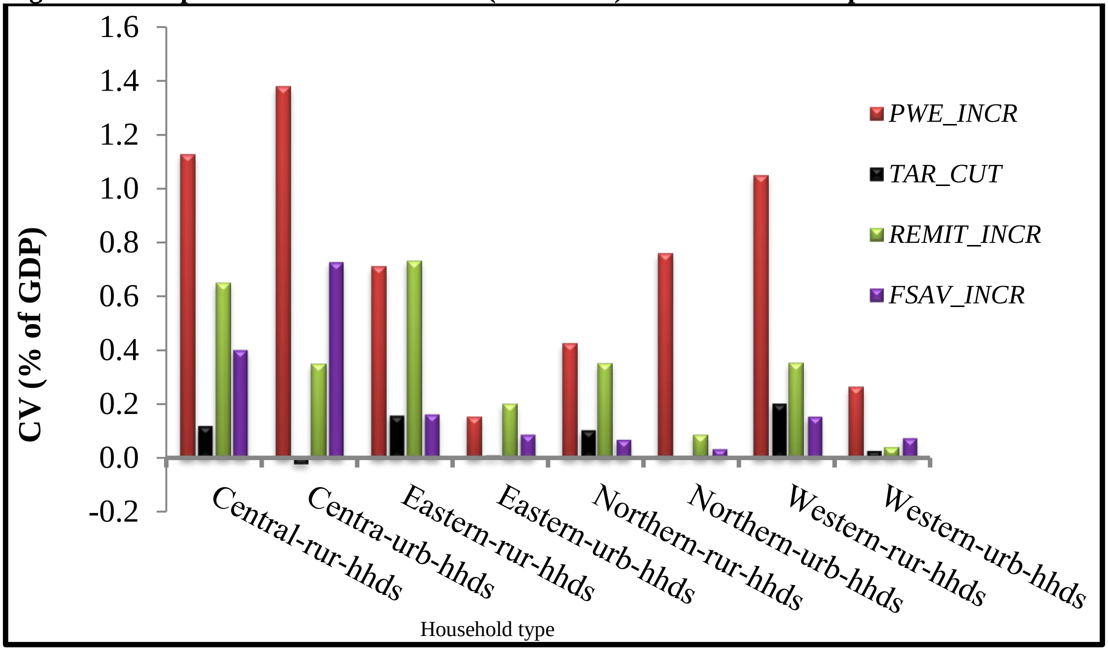
The increase in foreign savings into Uganda (i.e. foreign investment) increases the welfare of central region households more compared to households in other regions with both compensating and Equivalent Variation measures varying between 4 thousand million to 70 thousand million shillings respectively (about 0.1 percent to 0.7 percent of GDP). The increase in welfare of central region households could be attributed to the fact that the shock is associated with the decline in price of imports, PM_c and the consumer price index of urban based household groups, CPI_h. Note that imports are mostly consumed by urban households. Increased expenditure on imports increases the welfare of urban households relative to rural based

Table 8.8.3 Impact of Simulations on Compensating Variation (Million Uganda. Shillings)

Household type	*Base income*	*PWE_INCR*	*TAR_CUT*	*REMIT_INCR*	*FSAV_INCR*
Central-rur-households	2,258,540	123,750	12,179	71,572	40,598
Central-urb- households	3,569,255	151,542	-2,216	38,526	73,643
Eastern-rur-households	1,631,092	78,095	16,142	80,611	16,647
Eastern-urb-households	488,895	16,806	1,051	22,086	9,016
Northern-rur-households	811,467	46,684	10,578	38,777	7,068
Northern-urb- households	264,655	83,340	909	9,529	3,614
Western-rur-households	1,775,138	115,229	20,589	39,043	15,755
Western-urb-households	663,268	28,995	2,760	4,385	7,702

Source: Own computations. CGE Model Results. *PWE_INCR*: 30% increase in the world price of exports; *TAR_CUT*: 50% decrease in import taxes; *REMIT_INCR*: 40% increase in workers remittances; *FSAV_INCR*: 40% increase in foreign savings/foreign direct investment.

Figure 8.8.3 Impact of Simulations on CV (% of GDP) of Household Groups



Source: Own Computations. CGE Model Results. *PWE_INCR*: 30% increase in the world price of exports; *TAR_CUT*: 50% decrease in import taxes; *REMIT_INCR*: 40% increase in workers remittances; *FSAV_INCR*: 40% increase in foreign savings/foreign direct investment.

In general, urban households experience a lower CV (as % of GDP) for any given shock because these price index for the basket of goods and services, CPI_h consumed by these households decreases after shock leaving them better off compared to rural based households who experience an increase in price index for the same basket of goods and services, CPI_h and should therefore be compensated to attain the same level of utility before the price increase. In addition, the increase in the world price of exports, *PWE_INCR* leads to an increase in demand for imports which are now cheaper following the appreciation of the exchange rate. However, the price of goods supplied domestically, PD_c relative to the price of imports, PM_c

increases. Imports are mostly consumed by urban households. Domestic goods become expensive to rural based households and this decreases their welfare. To maintain the same level of welfare, these households would require a higher CV.

8.8.4 Impact of Simulation on Household Utility

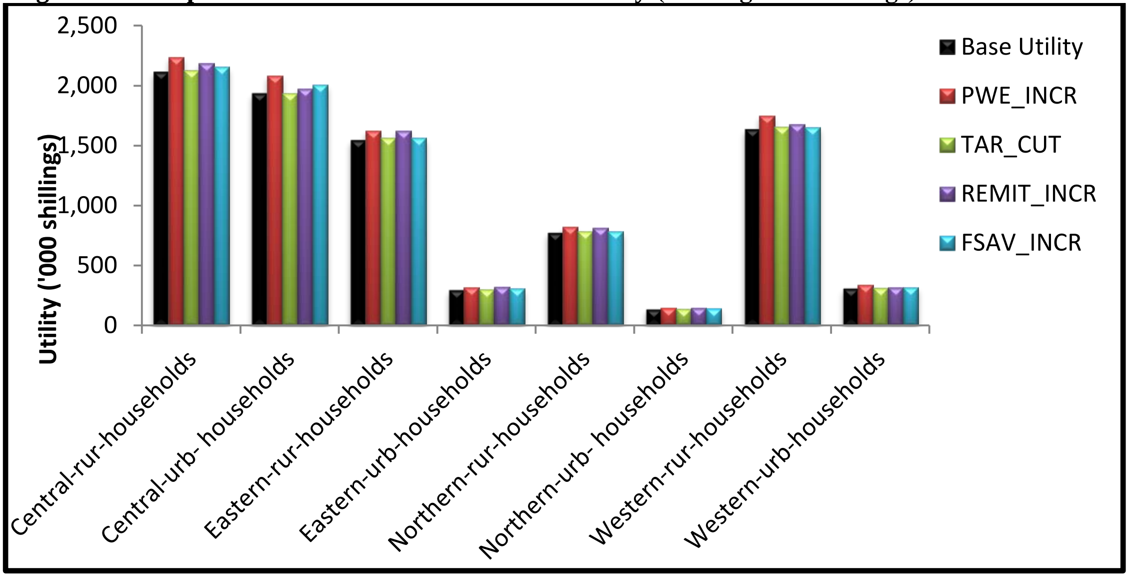
The impact of simulations on real household utility is presented in Table 8.8.4 and Figure 8.8.4 below.

Table 8.8.4 Impact of Simulations on Household Utility

Utility (UGX)	*Base Utility*	*PWE_INCR*	*TAR_CUT*	*REMIT_INCR*	*FSAV_INCR*
Central-rur-households	2,116,459	2,237,055	2,128,328	2,186,226	2,156,041
Central-urb- households	1,936,509	2,085,054	1,934,345	1,974,153	2,008,373
Eastern-rur-households	1,547,198	1,623,180	1,562,896	1,625,561	1,563,390
Eastern-urb-households	298,222	314,690	299,244	319,717	306,989
Northern-rur-households	775,626	821,128	785,922	813,326	782,502
Northern-urb- households	137,385	145,566	138,270	146,666	140,902
Western-rur-households	1,637,950	1,750,235	1,658,009	1,675,980	1,653,302
Western-urb-households	311,632	340,031	314,324	315,910	319,139

Source: Own Computations. CGE Model Results. *PWE_INCR*: 30% increase in the world price of exports; *TAR_CUT*: 50% decrease in import taxes; *REMIT_INCR*: 40% increase in workers remittances; *FSAV_INCR*: 40% increase in foreign savings/foreign direct investment.

Figure 8.8.4 Impact of Simulations on Household Utility ('000 Uganda shillings)



Source: Own Computations. CGE Model Results. *PWE_INCR*: 30% increase in the world price of exports; *TAR_CUT*: 50% decrease in import taxes; *REMIT_INCR*: 40% increase in workers remittances; *FSAV_INCR*: 40% increase in foreign savings/foreign direct investment.

The simulation results in Table 8.8.4 and Figure 8.8.4 suggest that an increase in the world price of exports, *PWE_INCR* generates the highest utility for all household groups regardless of region and residence. This is followed by an increase in workers remittances, *REMIT_INCR*. The increase in household utility is more significant with central region households, and rural based households in the eastern, northern and western regions. The increase in real household utility is due to a decrease in the consumer price index of household groups, CPI_h. The decrease in the consumer price index leads to an increase in real household incomes and expenditure based utility respectively. The increase in household incomes is due to an increase in employment of low skilled labour following an increase in world export price (*PWE_INCR)* and an increase in workers remittances (*REMIT_INCR)*. Unlike urban based households, rural based households are endowed with low skilled labour. Low skilled labour is dominantly employed in agriculture which is rural based and has strong linkages with the export sector. The increase in household utility is between 300 thousand and 2,300 thousand shillings respectively.

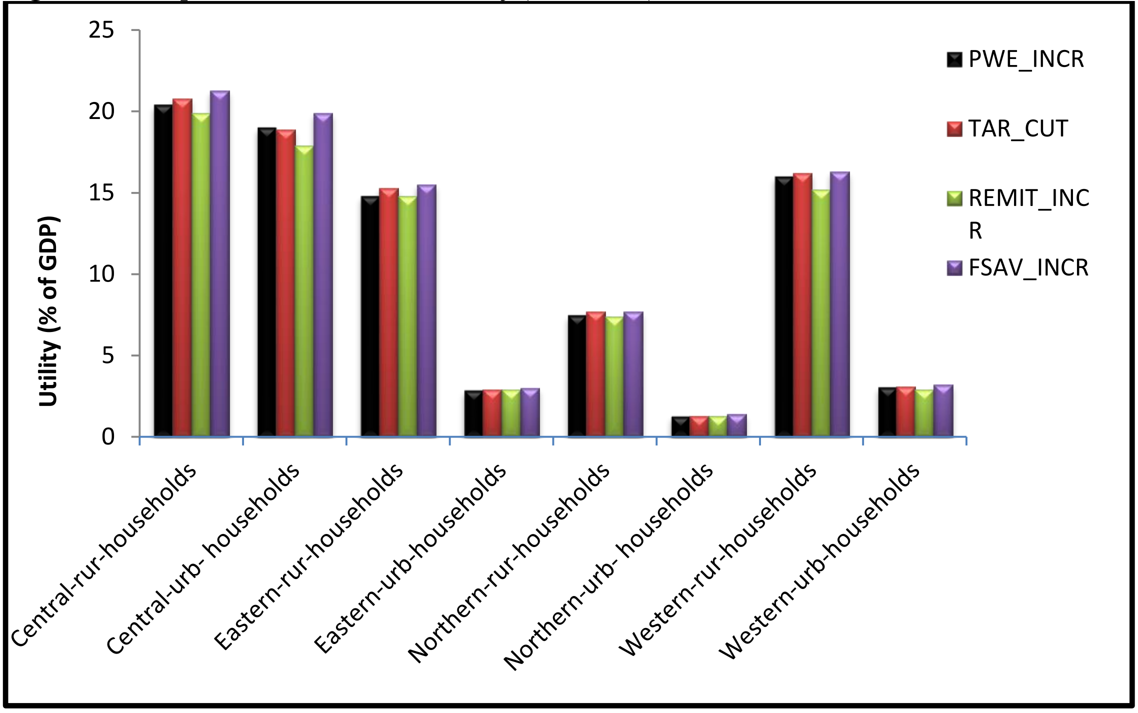
When measured as a percentage of GDP, Table 8.8.5 and Figure 8.8.5 shows that the utility of rural based households accounted for about 5 percent to 22 percent of GDP, while that of urban based households accounted for about 2 percent to 20 percent of GDP in all simulations.

Table 8.8.5 Impact of Simulations on Utility (% of GDP)

Household Category	*Base Utility*	*PWE_INCR*	*TAR_CUT*	*REMIT_INCR*	*FSAV_INCR*
Central-rur-households	21	20.4	20.8	19.9	21.3
Central-urb- households	19.2	19	18.9	17.9	19.9
Eastern-rur-households	15.4	14.8	15.3	14.8	15.5
Eastern-urb-households	3	2.9	2.9	2.9	3
Northern-rur-households	7.7	7.5	7.7	7.4	7.7
Northern-urb- households	1.4	1.3	1.3	1.3	1.4
Western-rur-households	16.3	16	16.2	15.2	16.3
Western-urb-households	3.1	3.1	3.1	2.9	3.2

Source: Own Computations. CGE Model Results. *PWE_INCR*: 30% increase in the world price of exports; *TAR_CUT*: 50% decrease in import taxes; *REMIT_INCR*: 40% increase in workers remittances; *FSAV_INCR*: 40% increase in foreign savings/foreign direct investment.

Figure 8.8.5 Impact of Simulations on Utility (% of GDP)



Source: Own Computations. CGE Model Results. *PWE_INCR*: 30% increase in the world price of exports; *TAR_CUT*: 50% decrease in import taxes; *REMIT_INCR*: 40% increase in workers remittances; *FSAV_INCR*: 40% increase in foreign savings/foreign direct investment.

8.9 Conclusion

This chapter discussed the construction of inequality indices and welfare measures and analysed the impact of selected exogenous changes and policies on inequality and welfare measures. Specifically, the impact of simulations on compensating and equivalent variations of different households groups (both in real terms and as percentage of real GDP) are illustrated and explained. In addition, the post shock utility of each household group is discussed and contrasted with the post shock EV and CV. It is found that not all exogenous changes and policies that increase household incomes are responsible for increasing household welfare. In the next chapter, we discuss the policy implications and policy prescriptions, and compare and contrast our key findings with

Chapter 9

9.1 Concluding Remarks and Policy Recommendations

The purpose of this chapter is to give a summary of the dissertation. This summary includes the policy recommendations based on the outcomes of SAM multiplier and the effects of simulations with the CGE models for Uganda. The policy recommendations made are guided by the research questions that were proposed in Chapter four. In addition, this chapter provides the shortcomings of the study and provides the direction for future research.

The key theme that guided this dissertation was: The identification of Uganda's key sectors with significant linkages to the rest of the economy can enhance the ability of policymakers to influence the outcomes of policy changes. The key research question was, what are the growth, poverty, and welfare implications of the economic challenges Uganda's economy faces? Put in a different way, how and which economic agents and sectors are mostly affected as a result of some selected exogenous changes and policy shocks? To answer the main research questions, this dissertation used the commonly used demand driven SAM multiplier and CGE models.

The process of identifying the sources of growth and poverty alleviation began with the identification of the key sectors of Uganda's economy, followed by the microeconomic and macroeconomic effects of selected exogenous changes and policies on the economy. These effects of simulations were analysed using the SAM multiplier and CGE models. These simulations were selected based on the socioeconomic challenges facing Uganda's economy (i.e. how to achieve sustainable economic growth and to alleviate) as highlighted in the National Development Plan (also known as the Poverty Reduction Strategy Paper). These simulations are: i) a 30 percent increase in the world price of exports; ii) trade liberalisation through a 50 percent decline in import tariffs; iii) a 40 percent increase in migrant workers remittances; and iv) an increase in foreign savings or net borrowing from abroad; It is important to note that when using the SAM multiplier model, the impact of simulations are overestimated compared to the CGE model (i.e. the magnitude of exogenous changes and policy shocks are higher with the SAM model and with a reversal of impact signs in some cases). For example, the SAM multiplier model predicted a significant decline in sectoral output, factor and household incomes with a tariff reduction experiment. On the Other hand, the CGE model predicted an increase in factor and household incomes. This is due to the limiting assumptions under which the SAM multiplier model operates (i.e. fixed prices, no input substitution, linear production functions, and underemployment of resources or excess capacity). On the contrary, the CGE model allows for price changes, input substitution, and at least some factors are fully employed and some sectors operate at fully capacity. Under the CGE model the behaviour of various agents can be modelled for example, factor demands depend on prices, and household incomes depend on factor demands. The SAM multiplier model over estimates the effects of simulations, for example an increase in commodity exports produced relatively larger impacts on factor and household incomes compared with the increase in world price of exports in the CGE model. This is due to the fact that in the CGE model, this simulation was treated as a price shock (i.e. prices allowed to change) and a quantity shock under the SAM multiplier model (prices assumed to remain constant).

It is worth noting that the SAM multiplier model is based on assumptions which limit its use in full assessment of the impact of exogenous changes and policies. The model is linear and assumes prices are fixed (i.e. infinitely elastic supply) and that any changes in demand reflect changes in supply; the model assumes the existence of excess capacity of production (i.e. the economy operates below its production possibility frontier) and any increase in demand is matched by a corresponding increase in supply; the SAM multiplier model assumes that average propensities of endogenous accounts remain constant and that linkage effects are linear and there is no behavioural change. Finally, the model assumes that there is no input or factor substitution. On the other hand, the CGE model improves the SAM multiplier model and is flexible to the specific features of the country being modelled. In particular, the model allows for input substitution and price changes. Thus, consumer demand patterns depend on relative prices and incomes, and demand for factors depend on factor prices. In addition, household incomes depend on factor demands.

Selected Key Findings and Policy Recommendations

We began with the SAM multiplier decomposition to identify key sectors for Uganda (i.e. sectors with strong linkages to the rest of the economy). Our findings revealed that Uganda's economy is characterised by weak inter-sectoral linkages, with the size of multipliers between 0.02 units and 1.6 units given a unit change in exogenous demand for any given sector. Despite the small magnitude of these inter-sectoral linkages, a number of sectors were identified as potential candidates for growth and poverty alleviation in Uganda. These were: Agriculture, Food Processing, Trade Services, Education and Health, and Other Services. The decomposition of agriculture's aggregate multiplier indicates that raising agricultural export demand by 100 units would causes agricultural output to increase by an additional 63 units, manufacturing to increase by 20 units, Food Processing to increase by 30 units, and Trade Service to increase by 30 units. The total output multiplier effect is highest for agriculture, implying that a 100 unit expansion of agriculture output would lead to a more than twice increase in aggregate output when all the linkages are accounted for. The increase in agriculture's aggregate output given a unit exogenous demand suggests that agriculture has the potential to increase household incomes and alleviate rural and urban poverty in Uganda. This is further supported by the fact that agriculture has strong linkages to the rest of the economy, with its production and consumption linkages directed towards sectors that use large shares of domestically produced goods and services (i.e. food processing, other manufacturing, and private services). The ranking of sectors for rural wage and household income generation, for GDP or value added multipliers, Output multipliers, and employment generation all confirm that agriculture is the key sector in Uganda.

A number of studies have analysed the importance of output growth in the agriculture sector as a means of reducing poverty in Uganda. Using the SAM multiplier analysis and the class of decomposable poverty measures proposed by Foster, Greer, and Thorbecke (Foster, Greer, and Thorbecke, 1984) and the 1999 SAM for Uganda, Okalang (2008) found that agriculture production activities had the highest distributional and poverty alleviation effects among all sectors (poverty alleviation effect is a product of the modified fixed price effect and the poverty sensitivity effect). Specifically agriculture had poverty alleviation effects of between 0.28 and 0.37, followed by services (0.32 to 0.18) and, manufacturing (0.298 to 0.147). His argues that in order to alleviate rural household poverty, the government should increase investment in agriculture (i.e. increase agro-processing and marketing of farmers output, building and maintaining rural infrastructure, training of farmers, and provision of farm inputs and credit facilities). This will increase agriculture production and incomes of rural households whose livelihoods depend on agriculture. Increased agriculture production will also stimulate the manufacturing sector since most industries use inputs from the agriculture sector.

Using the CGE model, the effects of a 30 percent increase in the world price of exports on real GDP, welfare, and job creation are expansionary. Real GDP at factor cost increases by 9 percent following the increase in world export prices. Household incomes and welfare increases significantly but are higher for rural based households. The increase in incomes is between 4 percent and 7 percent. The increase in employment for sectors with significant linkages to the export sector is responsible for the increase in household incomes. Consequently, employment of low skilled labour is significantly higher in agriculture (accounting for 60 percent of total jobs created). Sectoral output for domestic use and exports increases especially in sectors with strong linkages to exports.

The policy implications of an increase in world export prices on Uganda's economy are rather straight forward. In order to increase output in the agriculture sector, Uganda need should make significant investments in the sector in order to increase its value added output and household incomes. Low output growth in the agriculture sector has been the primary factor behind its declining value added share in GDP and to achieve rapid economic transformation. Our findings are consistent with the findings by Thurlow *et al*., (2008). Using a CGE model and micro-simulation model, they find that it is possible for Uganda to attain the required target of 6 percent output growth in the Agriculture sector. This rate is required to significantly reduce the number of Ugandans living below the poverty line, while improving the livelihoods of rural and urban households. They recommend the following interventions: fulfilling the Maputo declaration of allocating about 10 percent of the national budget to agriculture, investing in and maintaining rural infrastructure, training and equipping farmers with better farming practices, increasing farmers access to credit facilities by reviving cooperatives in all regions of the country, and supporting broad based agriculture growth to include crop diversification, fisheries and livestock. Finally, improving the quality of the labour force through education and training is essential so as to equip the labour force with the skills required to bring about productivity growth in the agriculture sector. This can be achieved by adopting private-public sector participation in designing the education curriculum, building vocational training centres, and attracting more foreign aid and investment where domestic resources are not adequate to finance all government programs.

Dorosh *et al*., (2006) developed an agriculture based CGE model of Uganda's economy to analyse the welfare and production effects of technical change, market incentives, and rural incomes. They conclude that output growth in the agriculture sector could significantly increase rural incomes if markets performed better and that producer incentives are maintained. In addition, a 5 percent increase in agriculture productivity is found to increase real consumption among rural farmers by 1.2 percent to 2.1 percent, while urban groups benefit even more as their incomes increase by 2.4 percent to 2.7 percent. Generally, an increase in agricultural output growth and productivity benefitted all households in the country. Compared to an increase in world export prices discussed above, Dorosh *et al*. (2006) analysed the effects of a 60 percent decrease in export price of coffee. Their findings suggest a decline in coffee exports by 68 percent reduced real incomes and consumption. A depreciation of the exchange rate by 11.3 percent reduced import demand but increased incentives for non-coffee exports. Our findings suggest that a 30 percent increase in world export prices would increase exports by 36 percent and private consumption by 6.2 percent. The exchange rate would appreciate by 15 percent and imports would increase by 6 percent to equilibrate the current account balance.

The effects of tariff cuts by 50 percent on GDP, welfare, and employment of low skilled labour were at most expansionary. Real GDP increases in real terms, and both imports and exports increase in real terms relative to their base values. Government revenue as well as savings decreases following the reduction in import taxes. The exchange rate depreciates, thus providing an incentive for exports to increase to clear the current account deficit. Private consumption increases as a result of the increase in factor incomes. The welfare of both rural and urban household's increases (i.e. trade liberalisation is pro-poor). A closer look at the sectoral effects of liberalisation suggests capital intensive sectors would be negatively affected. Specifically, the output and number of jobs created in manufacturing after the shock decreases. It should be noted that the decline in output of the manufacturing sector could be attributed to a decline in demand arising from domestic demander's preference of imported goods that are now cheaper following the reduction in tariffs. Other factors responsible for the decline in manufacturing output that could not be captured in our analysis include: competition from cheap imports which flood the domestic market and reduces aggregate demand and share of locally manufactured goods in aggregate demand and gross output. Examples include: cheap textiles from China, Kenya, and Uganda's other regional trading neighbours.

Matovu *et al*., (2009) applied a Computable General Equilibrium (CGE) model to analyse the impact of tax reforms on household welfare. They found that partial or full trade liberalisation had a positive impact on the macro-economy by increasing real GDP, private consumption, exports and imports. However, at the sectoral level the output of agriculture and mining, manufacturing decreases, as well as the welfare of those engaged in these activities shock. Similarly, the welfare of most of rural household's decrease as a result of tariff cuts, implying that trade liberalisation was not pro-poor. However, the welfare of urban households increased in all regions. They attribute this to a significant portion of imports in their consumption baskets. They also suggest that full trade liberalisation would not benefit poor households in all regions of the country because their livelihoods depend on agriculture which is negatively affected to foreign competition. We do not observe such a trend in welfare following partial liberalisation, but our results support the argument that the reduction in import tariffs reduced the output of the manufacturing sector but increased the output of agriculture and other sectors. However, our results suggest that at most improved trade liberalisation enhanced the welfare of both rural and urban households as measured by the compensating and equivalent variation (as percentage to GDP). In a related study, Matovu *et al*. (2009) uses a CGE model to investigate the impact of introducing VAT and zero rating all food items and agricultural products on household welfare. They found that VAT was progressive and zero rating agriculture products improved the welfare of low income households, who consume mainly food items.

Mbabazi (2002) employs a Computable General Equilibrium model to Uganda's economy to investigate the shot-rum welfare effects of trade liberalisation. She suggests that the welfare effects of trade liberalisation are at most minimal and this limits its ability to solve developing country problems. She identifies differences in welfare gains among households and it is therefore misleading to consider aggregate welfare gains. She advocates for the understanding of inter-sectoral linkages and the provision of safety nets e.g. transfers to the poor. On the international scene, there is evidence to suggest that trade liberalisation is an important component of pro-poor development strategy and is found to generally increase economic opportunities for consumers and producers as well as increasing household and factor incomes (Winters *et al*., 2004). Our results have demonstrated that the highest number of jobs created following the decline in import tariffs are in the agriculture sector. This highlights the importance of this sector in improving household and factor incomes especially in rural areas and alleviating household poverty.

Finally, trade liberalisation through tariff cuts is accompanied by a significant reduction in government revenue and this could adversely affect implementation of government programs. There is need to identify tax revenue sources if the country is to maintain the same level of fiscal deficit (i.e. widening the tax base). Even though the policy reform is welfare and growth enhancing, it should be implemented with caution. In sectors and industries where the country has direct or strategic interests, liberalisation should be gradually implemented (i.e. such industries or sectors should be protected from foreign competition up to the level when they can compete favourably); and the government should lessen the incidence of taxes using transfers (Chia *et al*., 1992). In most cases, the secondary effects and burden of policy reforms are borne by the poor who are reliant on transfers.

The simulation with a 50 percent increase in migrant workers remittances has policy implications on household welfare and other macroeconomic variables. Real GDP, employment, consumption, household incomes increase relative to their baseline scenarios. Regarding the impact on welfare, the increase in migrant workers benefits both rural and urban households in all regions of the country. In addition, the increase in migrant remittances generated the largest reduction in inequality measures (Figure 8.1.3). This perhaps suggests that incomes directly received by households significantly reduce inequality and could be key to poverty alleviation. As noted earlier, migrant remittances are used to buy land, agriculture inputs, scholastic materials, food, and to finance savings and investment. The Uganda government should therefore target migrant remittances as potential sources for growth and poverty alleviation. Studies have shown that incomes of households with migrant workers overseas are positively affected and there are notable gains in employment and production (Taylor and Adelman, 1996).

Recognising the role played by workers remittances, the government of Uganda created an investment desk at the Ministry of Foreign Affairs to provide information about domestic investment opportunities for Ugandans living and working abroad so as to increase remittances. It is important to note that this study is the first to analyse the economy wide effects of increasing migrant remittances in Uganda. Our findings have policy implications for Uganda. First, the government could target more remittances by exporting surplus labour to countries that have acute shortages of low and high skilled labour; secondly, the government could create an international bond to attract diaspora finance thereby increasing the inflow of foreign remittances and domestic investment. This will increase ownership of domestic assets by Ugandans (i.e. promoting local content in the management of economic affairs).

The effects of foreign savings or net borrowing from abroad (i.e. allowing flexibility on the BOP account) on economic growth and poverty alleviation prospects were examined by simulating the model with a 40 percent increase in the foreign savings relative to the base. The immediate effects suggest that foreign savings had a small but positive impact on GDP, total absorption, private consumption, and household incomes. However, the shock had a negative impact on employment as well as sectoral output. Activities that experience a fall in output and negative employment are those that are highly intensive in capital (i.e. mining, other manufacturing, food processing, and transport). A shock to foreign savings is also associated with the lowest change in welfare measures (i.e. post shock equivalent and compensating variation as a percentage of GDP) compared to other simulations in this study. The decline in employment, output and welfare following a 40 percent increase in FDI has policy implications for Uganda. First, for FDI to effectively contribute to growth and poverty reduction, it should be allocated to activities or sectors which have the potential to increase employment opportunities such as agriculture. Most FDI activities in Uganda are largely concentrated in urban areas, and dominated by investments in services and manufacturing which employ a small portion of highly skilled labour. The share of FDI in agriculture is not enough to generate the required transformation of the sector. This calls for the Uganda government to encourage private sector participation in agriculture through private-public sector partnership thereby attracting the much needed investment for agriculture growth.

Dorosh *et al*. (2002) investigates the effects of a 20 percent increase in foreign savings on welfare, and production, limiting his analysis to the agriculture sector. Using a CGE modelling framework, his findings suggest that household savings decline and consumption spending increases. The increase in consumption spending raises the demand for traded and non-traded goods and imports. The price of non-traded goods increases while import prices decline due to exchange rate appreciation. The final effects are an increase of domestic output, an increase in imports, a decline in exports, and an appreciation of the exchange rate. In our analysis we find an increase in household welfare significantly higher for rural households compared to urban households following a 40 pecent increase in foreign savings. Dorosh *et al*., (2002) report an increase in household welfare for all households except the urban non-poor. They attribute this difference to ownership of land whose returns increase in non-coffee growing areas, a fall in food prices, and an increase in agriculture productivity. Overall, the decline in output of agriculture sector in this study and this dissertation following an increase in foreign savings in Uganda has policy implications to the economy. Government should try as much as possible to promote investment in agriculture because the sector for Uganda. This can be done by allocating large arable land for modern farming to increase agriculture production and productivity, while increasing value addition through agro-processing and exports, a key component and pillar of the national development plan. Creating incentives that promote private sector investment in agriculture could unlock the potential of agriculture and contribute to inclusive growth and poverty alleviation. This can be done by making agricultural land available to investors, removing bottlenecks that impede registration of private businesses, and investing in infrastructure (i.e. markets, roads and power).

It should be noted that this dissertation goes beyond analysing the sources of growth and poverty reduction in Uganda, but also examines the impact of various policies on inequality and welfare. By constructing welfare and inequality indices, it is found that an all simulations are associated with reduced inequality but most significantly, the increase in migrant remittances. On the other hand, all simulations are characterised by a significant increase in rural based real household welfare (as measured by an increase in real household consumption expenditure). The increase in welfare is highest with the increase in the world price of exports given its linkages with agriculture and the urban and rural households. Finally, a sensitivity analysis using an alternative factor market closure and trade parameters is conducted and it is found that all simulations produced robust results (i.e. no change in direction of the impact of experiments on selected variables). The CGE model for Uganda is found to be consistent.

Our results suggest that the SAM multiplier and CGE modelling framework used in this dissertation answered our key research questions. Both models suggest that Agriculture (crop and animal farming, forestry and fisheries), Food Processing, Trade Service, and Other Services are the key sectors for growth and poverty reduction prospects in Uganda. Based on these sectors, likely policies for growth and poverty alleviation include: investment in agriculture with emphasis on diversification of export crops, fish farming, value addition through food processing and industrialisation. To increase agriculture production and productivity, Uganda should focus on in increasing investment in rural infrastructure, training of farmers in the use of modern agricultural technologies, and improving farmer’s access to credit facilities. Because agriculture is the dominant employer of labour and source of household income in rural areas, the implications to poverty reduction of a well-developed strategy for agriculture transformation are quite obvious. The effects of simulations on agriculture output, employment and household incomes presented in this dissertation support the above argument.

Our analysis identified the contribution of social services (i.e. education and health) as potential candidates for growth and poverty alleviation in Uganda through the creation of employment opportunities and increasing of household incomes. The Ugandan government should therefore make significant investments in education and health and strive to achieve regional balance in the provision of these services to reduce unequal development and other regional imbalances. On the other hand, investments in education should target vocation training which prepares graduates to be job creators and to equip the youth with skills for transforming rural areas by participating in agriculture (i.e. the making and use of simple farming tools, and provision of agriculture extension services where farmers are trained and equipped with better agricultural technologies should be a priority).

It should be noted the use of the SAM multiplier model to identify key sectors for Uganda is not without limitations. The analysis ignored price and technological changes, changes in resource endowments, and changes in the composition of trade (i.e. domestic and foreign markets that affect demand) and global commodity prices. Further, the computation of the SAM accounting multipliers did not take into account the marginal share of consumption spending on each commodity by each household group. The calculated forward and backward linkages are based on the average expenditure but not the marginal expenditure propensities (i.e. analysis assumed that each household group consumes the same basket of goods after an exogenous change in demand). In addition, the analysis ignored the impact of HIV/AIDS (i.e. loss of lives due to HIV could have affected labour mobility and productivity and the performance of the agriculture sector, leading to reduced household incomes and increased household poverty), corruption, population growth, size, and composition, and civil conflicts that have had significant consequences on the socioeconomic performance of Uganda's economy. The simulations performed in this dissertation are not an exhaustive list of the challenges Uganda's economy faces. Perhaps, the selection of other challenges and policy experiments could generate a whole different set of key sectors for growth. Given the above limitations, caution should be taken when using results from the SAM multiplier model in economic policy formulation and implementation.

Data limitations prevented the disaggregation of activities and factors in the SAM on a regional basis. A regional disaggregation of activities and factors would provide a better understanding of the impact of shocks on household in the Ugandan economy i.e. which regions and households are endowed with certain types of labour and what is the impact of shocks on output, employment, and incomes of households in these regions.

Future Research

The use of SAM based CGE models in economic policy analysis are not without limitations. Future research will address these limitations. On the other hand, the production of this thesis has taken quite a number of years which might be a limiting factor in an operational policy environment characterised by time constraints and data limitations (i.e. data to compute trade and linear expenditure system parameters, and demand elasticities. To overcome the time constraint and other data limitations, other methods could be used to identify Uganda's sectors of growth and poverty alleviation. One such method is the growth accounting method. However such a methodology might not address key sectoral linkages and economy wide features that are captured by a well disaggregated SAM. In addition, our CGE model is static (i.e. there are no dynamics in the model and the impact of some simulations might take longer to be realised).

Static CGE models ignore the long-term effects of policies since these models analyse short-term effects. The effects of long-term factors that change over-time e.g. capital stock and labour productivity need to be analysed using a dynamic CGE model. In future, this study could be extended to identify key sectors for growth and poverty alleviation using a dynamic CGE model and a SAM with regional disaggregation of activities and factors.

Uganda will soon become an oil and gas producing economy. When data becomes available, it would be important to analyse the effects on growth and poverty alleviation of Uganda's nascent oil and gas sector. The government intends to invest a significant share of oil revenues in agriculture and infrastructural development and this is expected to have a significant impact on sectoral output, growth and poverty reduction.

The refining of petroleum products and export of crude oil will boost the development of Uganda's stock market. This study ignored the role of money and interests rates on Uganda's growth and poverty alleviation prospects. With availability of data, the construction of a financial CGE model will provide a better understanding of the role of financial and capital markets in Uganda's economy.

The impact of HIV/AIDS especially on labour mobility and productivity especially in the agriculture sector and on household incomes was ignored in this study. This dissertation can be improved with more data availability (i.e. household consumption data, HIV/AIDS and its impact on different household groups that are disaggregated in the SAM). In addition, we could compute the parameters for the linear expenditure system (LES) and improve on the Cobb-Douglas (CD) function which assumes equality of average and marginal expenditure propensities for each household category. The Linear Expenditure system (Stone-Geary function) is a modification of the CD and CES production functions and introduces a minimum level of demand for each good and is assumed to describe each household consumption function thus eliminating the unitary elasticity of demand assumed in the CD function.

Generally, the SAM multiplier model could be improved by using the CGE model with its linearity and non-linearity specifications under the assumption of fixed prices (Robinson *et al*., 1996, Robinson, 2003). The CGE modelling framework mainly focused on the production side of the economy. This analysis can be extended by exploring in detail the consumption side of the economy in which various demand systems, especially the Stone Geary system and the almost ideal system. These could provide a better understanding of how CGE modelling operates. Future research could also undertake the use of different macro closures (i.e. neoclassical closures that assumes investment is endogenous and that capital is not activity specific but fully employed in Uganda). In addition, constructing a financial CGE model could greatly enhance our understanding of the impact of exogenous changes on the financial sector and its impact on micro and macroeconomic variables. Given the high level of graduate and youth unemployment in Uganda, the use of the unemployment closure for high skilled labour could help to identify suitable sectors and policies to increase employment of high skilled labour.

Future research will compare and contrast the policy recommendations of this dissertation with findings of subsequent studies if such studies are aimed identifying suitable interventions policy makers in Uganda could implement to achieve all inclusive growth and poverty alleviation in Uganda.

Appendix A

A1 List of Sets used in the CGE Model for Uganda

10 Activities Set A; $a \in A$	AGRI_A MIN_A PROC_A MAN_A ELEC_A CONS_A TRS_A TRAN_A HEAL_A OTH_A	Agriculture, Fishing and Forestry Mining and Quarrying Food Processing Manufacturing Water & Electricity Service Construction Wholesale and Retail Trade Transportation & Communication Service Health and Education Service Other Service
10 Commodities Set C; $c \in C$	AGRI_C MIN_C PROC_C MAN_C ELEC_C CONS_C TRS_C TRAN_C HEAL_C OTH_C	Agriculture, Fishing and Forestry Mining and Quarrying Food Processing Manufacturing Water & Electricity Service Construction Wholesale and Retail Trade Transportation & Communication Service Health and Education Service Other Service
8 Exportable Commodities Set $CE \subset C$	AGR_C; MIN_C; PROC_C; MAN_C; ELEC_C; TRS_C; TRANS_C; OTH_C	
6 Importable Commodities Set $CM \subset C$	AGR_C; MIN_C; PROC_C; MAN_C; TRAN_C; OTH_C	
2 Non-Exportable Commodities Set $CNE \subset C$	CONS_C; HEAL_C	
4 Non-Importable Commodities Set $CNM \subset C$	ELEC_C; CONS_C; TRS_C; HEAL_C	
9 Primary Factors Set F ={LAB, CAP}, $f \in F$	LS_RM LS_RF LS_UM LS_UF HS_RF HS_RM HS_UM HS_UF K	Low Skilled Labour, Rural, Male Low Skilled Labour, Rural, Female Low Skilled Labour, Urban Male Low Skilled Labour, Urban Female High Skilled Labour, Rural Female High Skilled Labour, Rural Male High Skilled Labour, Urban Male High Skilled Labour, Urban Female Capital
11 Institutions Set I={H, E, G, R}, $i \in I$	CR_H CU_ H ER_ H EU_ H NR_ H NU_ H WR_H WU_H E G R	Central Rural Household Central Urban Household Eastern Rural Household Eastern Urban Household Northern Rural Household Northern Urban Household Western Rural Household Western Urban Household Enterprise Government Rest of The World
10 Domestic Institutions $ID \subset I$	ID = {H, E, G}	
9 Domestic Non-Gov. Institutions $IDNG \subset ID$	$IDNG$ = {H, E}	

A2 List of Parameters used in the CGE Model for Uganda

Parameters	Description
aac_c	shift parameter in the CES output aggregation function
ava_a	shift parameter in the CES value added production function
aq_c	shift parameter in the CES aggregation of commodity c that is domestically produced and imported
ax_c	shift parameter in the CES transformation of commodity c that is domestically produced and exported
$cwts_c$	commodity weight in the *CPI*: $\sum_{c\in C} cwts_c = 1$
$hmpsdum_i$	marginal propensity to save dummy for institution i, $i \in H$
ia_a	quantity of investment i required as an intermediate input in *activity* a
$ica_{c,a}$	quantity of commodity c used as an intermediate input per unit of activity a output: $ica_{c,a} \geq 0$
mps_i	initial marginal propensity to save for institution i , $i \in IDNG$
pwe_c	world export price in local currency unit (Uganda shillings)
pwm_c	world import price in foreign currency units
qg_c	base year quantity of government demand for commodity c
$qinvi_c$	base year quantity of private investment demand
$shinc_{i,f}$	share for domestic institution *i* in the income of factor *f* : $\sum_{i\in I} shinc_{if} = 1;\ f \in F$
$shtr_{i,i'}$	share of income of domestic institution *i* in transfers from institution *i'* . Note that shares do not add up to 1.
ta_a	tax rate for activity a: $0 \leq ta_a \leq 1$
te_c	export tax rate: $0 \leq te_c \leq 1$
tm_c	import tariff rate: $0 \leq tm_c \leq 1$
tq_c	rate of sales tax: $0 \leq tq_c \leq 1$
ty_i	direct income tax rate for domestic institution i: $0 \leq ty_i \leq 1;\ i \in IDNG$
$\beta_{c,i}$	marginal share of consumption spending of institution i on commodity c: $\sum_{c\in C} \beta_{c,i} = 1$; $i \in IDNG$
$\theta_{a,c}$	yield of commodity c per unit of activity a: $\sum_{a\in A} \theta_{a,c} = 1$
$\delta ac_{a,c}$	share parameter in the CES output aggregation function
$\delta va_{f,a}$	CES value added function share parameter for factor f in activity a: $\sum_{f\in F} \delta va_{f,a} = 1$
δq_c	share parameter in the CES aggregation of commodity c
δx_c	share parameter in the CES transformation of commodity c that is domestically produced and exported.
ρva_a	exponent in the CES value added production function: $\rho va_a = \frac{1}{\sigma va_a} - 1,\ \sigma va_a > 0; \rho va_a > -1$
ρac_c	exponent in the CES aggregation function for commodity c: $\rho ac_c = \frac{1}{\sigma ac_c} - 1,\ \sigma ac_c > 0;\ \rho ac_c > -1$
ρq_c	exponent in the CES aggregation of commodity c that is domestically produced and imported: $\rho q_c = \frac{1}{\sigma q_c} - 1,\ \sigma q_c > 0; \rho q_c > -1$
ρx_c	exponent in the CES export transformation function: $\rho x_c = \frac{1}{\sigma x_c} + 1;\ \sigma x_c > 0; \rho x_c > 1$

A3 Equations in the CGE Model for Uganda

Eq. No.	**Equation Expression**	**No. of Eqs**
1	Activity production of a final good whose value added is obtained by a CES production function that uses all the primary factors: $QA_a = ava_a \left(\sum_{f \in F} \delta va_{f,a} QF_{f,a}^{-\rho va_a} \right)^{-\frac{1}{\rho va_a}}$; $a \in A$; $\rho va_a = \frac{1}{\sigma va_a} - 1$	10
2	Equilibrium in the factor market under perfect competition: Economy wide wage of factor f in activity a = Value of marginal product of factor f in activity a: $WFDIST_{f,a} WF_f QF_{f,a} = \left(\frac{\delta va_{f,a} QF_{f,a}^{-\rho va_a}}{\sum_{f \in F} \delta va_{f,a} QF_{f,a}^{-\rho va_a}} \right) PVA_a QA_a$; $f \in F, a \in A$	90
3	Quantity of investment by activity a $QIA_a = ia_a QA_a$; $a \in A$	10
3.1	For each activity, revenue = expenditure. This implies $PA_a QA_a = \sum_{f \in F} WFDIST_{f,a} WF_f QF_{f,a} + \sum_{c \in C} PQ_c QINT_{c,a} + PA_a QIA_a + ta_a PAQA_a$; $a \in A$; $f \in F$; $c \in C$. $\sum_f WFDIST_{f,a} WF_f QF_{f,a} = PVA_a QA_a$ is factor input cost = value added implied by equation 2 above $\sum_c PQ_c QINT_{c,a} = \sum_c PQ_c ica_{c,a} QA_a$ is material input cost implied by equation 5 below. $PA_a QIA = ia_a PA_a QA_a$ is activity investment implied by equation 3 above $ta_a PA_a QA_a$ is activity value added tax implied by equation 4 below.	-
4	Zero profit condition: Total revenue of each activity = Total costs of each activity on inputs $(1 - ta_a - ia_a) PA_a = PVA_a + \sum_{c \in C} PQ_c ica_{c,a}$; $a \in A$	10
5	Quantity of commodity *c* as intermediate input to activity *a* $QINT_{c,a} = ica_{c,a} QA_a$; $a \in A$; $c \in C$	100
6	Activity price (unit gross revenue) $PA_a = \sum_{c \in C} \theta_{a,c} PXAC_{a,c}$; $a \in A$	10
7	Quantity of output of commodity c from activity a $QXAC_{a,c} = \theta_{a,c} QA_a$; $a \in A$; $c \in C$	100
8	Aggregate quantity of domestic output of commodity c/commodity aggregation function: CES aggregation of the production levels of the different activities producing the commodity. QX is the output produced and sold at PX and produced with inputs $QXAC$ purchased at prices $PXAC$: $QX_c = aac_c \left(\sum_{a \in A} \delta ac_{a,c} QXAC_{a,.c}^{-\rho ac_c} \right)^{-\frac{1}{\rho ac_c}}$; $c \in C$; $\rho ac_c = \frac{1}{\sigma ac_c} - 1$	10

A3 CGE Model Equations Cont'd

Eqn. No.	Equation Expression	No. of Eqns.
9	First order condition for profit maximization from selling aggregate output QX at price PX : marginal cost of commodity c from activity a = value of marginal revenue product of commodity c from activity a $$PXAC_{a,c}QXAC_{a,c} = \left(\frac{\delta ac_{a,c}QXAC_{a,c}^{-\rho ac_c}}{\sum_{a\in A}\delta ac_{a,c}QXAC_{a,c}^{-\rho ac_c}}\right)PX_cQX_c\,;\ a\in A, c\in C$$	100
10	Export price of commodity c (domestic currency units) $$PE_c = pwe_c\left(1+te_c\right)EXR;\ c\in CE$$	8
11	Output transformation function for commodities that are exported and domestically supplied (a CET function transformation of two goods QD and QE into QX) $$QX_c = ax_c\left(\delta x_c QE_c^{\rho x_c} + (1-\delta x_c)QD_c^{\rho x_c}\right)^{\frac{1}{\rho x_c}}\ c\in CE\,;\ \rho x_c = \frac{1}{\sigma x_c}+1$$	8
12	Transformation for non-exported commodity c $$QX_c = QD_c\,;\ c\in CNE$$	2
13	Export and domestic output supply ratio for commodity c (optimal mix between exports and domestic sales). $$\frac{QE_c}{QD_c} = \left(\frac{PE_c}{PD_c}\frac{1-\delta x_c}{\delta x_c}\right)^{\rho x_c}\ ;\ c\in CE\,;\ \rho x_c = \frac{1}{\sigma x_c}+1$$	8
14	Domestic output value for exported and non-exported commodity c $$PX_cQX_c = PD_cQD_c + PE_cQE_c\,;\ c\in CE$$	8
15	Output transformation for non-exported commodity c produced domestically $$PX_cQX_c = PD_cQD_c\,;\ c\in CNE$$	2
16	Price of imported commodity c (paid by domestic consumers in local currency units) $$PM_c = pwm_c\left(1+tm_c\right)EXR\,;\ c\in CM$$	6
17	Quantity of goods supplied to domestic market (composite supply): A CES function aggregation of two goods, QM and QD to yield a composite commodity c: $$QQ_c = aq_c\left(\delta q_c QM_c^{-\rho q_c} + (1-\delta q_c)QD_c^{-\rho q_c}\right)^{-\frac{1}{\rho q_c}}\,;\ c\in CM\,;\ \rho q_c = \frac{1}{\sigma q_c}-1$$	6
18	Composite supply for non-imported commodity c with domestic production $$QQ_c = QD_c\,;\ c\in CNM$$	4
19	Import-domestic demand ratio for commodity c (optimal mix between imports and domestic output) $$\frac{QM_c}{QD_c} = \left(\frac{PD_c}{PM_c}\frac{\delta q_c}{1-\delta q_c}\right)^{\rho q_c}\ ;\ c\in CM\,;\ \rho q_c = \frac{1}{\sigma q_c}-1$$	6
20	Output value for composite supply of commodity c net of sales tax $$\left(1-tq_c\right)PQ_c\,QQ_c = PD_cQD_c + PM_cQM_c\,;\ c\in CM$$	6
21	Output value of non-imported commodity c net of sales tax $$\left(1-tq_c\right)PQ_c\,QQ_c = PD_cQD_c\,;\ c\in CNM$$	4

A3 CGE Model Equations Continued

Eqn	Equation Expression	No. of eqns.
22	Gross income of factor *f* $$YF_f = \sum_{a \in A} WF_f . WFDIST_{f,a}\, QF_{f,a};\ f \in F$$	9
23	Disposable income to domestic institution *i* from factor *f* $$YIF_{i,f} = shinc_{i,f}\left(YF_f - Y_{r,f}\right);\ i \in ID;\ f \in F;\ \sum_{i \in I} shinc_{i,f} = 1$$	90
24_1	Income of domestic non-governmental institution *i* $$Y_i = \sum_{f \in F} YIF_{i,f} + \sum_{i' \in IDNG} TR_{i,i'} + TR_{i,g} CPI + TR_{i,r} EXR;\ i \in IDNG$$	9
24_2	Total government income $$Y_g = \sum_{f \in F} YIF_{g,f} + \sum_{i' \in IDNG} ty_i Y_i + TR_{g,r} EXR + \sum_{c \in C} tq_c PQ_c QQ_c + \sum_{a \in A} ta_a PA_a QA_a + \sum_{c \in CM} tm_c EXR\ pwm_c QM_c + \sum_{c \in CE} te_c EXR\ pwe_c QE_c$$	1
25_1	Budget constraint of non-governmental domestic institutions $$DSAV_i + EXPE_i + \sum_{i' \in IDNG} TR_{i',i} + TR_{r,i} = (1 - ty) Y_i;\ i \in IDNG$$	9
25_2	Government expenditure $$EXPE_g = \sum_{c \in C} PQ_c QC_{c,g} + \sum_{i \in IDNG} TR_{i,g} CPI + TR_{r,g}$$	1
25_3	Budget constraint for the Government: $DSAV_g + EXPE_g = Y_g$	1
26_1	Marginal propensity to save adjustment for institution *i* $$\left(1 + hsdum_i . HSADJ\right) * mps_i = \frac{DSAV_i}{(1 - ty_i) Y_i};\ i \in H$$	8
26_2	Marginal propensity to save adjustment for enterprise $$\left(1 + ESADJ\right) * mps_E = \frac{DSAV_E}{(1 - ty_E) Y_E}$$	1
27	Total value of consumption spending by domestic non-governmental institution i on comm c $$PQ_c QC_{c,i} = \beta_{c,i} EXPE_i;\ \sum_{c \in C} \beta_{c,i} = 1;\ c \in C;\ i \in H$$	80
28	Quantity of commodity c consumed by government: $QC_{c,g} = qg_c GADJ;\ c \in C$	10
29	Quantity of fixed investment demand for commodity c: $QINV_c = qinvi_c IADJ;\ c \in C$	10
30	Market equilibrium condition for composite commodity c (total absorption) $$QQ_c = \sum_{a \in A} QINT_{c,a} + \sum_{i \in ID} QC_{c,i} + QINV_c;\quad c \in C$$	10
31	Market equilibrium condition for factor f: $\sum_{a \in A} QF_{f,a} + QFU_f = QFS_f;\quad f \in F$	9
32	Balance of payment condition, in foreign currency units $$\sum_{c \in C} pwm_c QM_c + \sum_{i \in ID} TR_{r,i} / EXR + \sum_{f \in F} Y_{r,f} / EXR = \sum_{c \in C} pwe_c QE_c + \sum_{i \in ID} TR_{i,r} + FSAV$$	1
33	Saving-investment balance with WALR dummy to be zero in equilibrium $$WALR = \sum_{i \in ID} DSAV_i + EXR . FSAV + \sum_{a \in A} PAQIA_A - \sum_{c \in C} PQ_c QINV_c$$	1
34	The Consumer Price Index for the price normalization rule: $CPI = \sum_{c \in C} cwts_c PQ_c$	1
35	Transfers between domestic non-governmental institutions $$TR_{i,i'} = shtr_{i,i'}\left((1 - ty_{i'}) Y_{i'} - DSAV_{i'}\right);\ i = i' \in IDNG$$	81
	Total number of equations	840

A4 List of Model Variables

Variable	Description	No. of Variables	How many are exogenous?
CPI	Consumer price index	1	1
$DSAV_i$	Domestic savings for domestic institution i	10	
$ESADJ$	Saving adjustment variable for Enterprise	1	
$EXPE_i$	Expenditure for institution i	10	1
EXR	Exchange Rate (local currency per unit of foreign currency)	1	
$FSAV$	Foreign savings	1	1
$GADJ$	Government consumption adjustment factor	1	1
$HSADJ$	Saving adjustment variable for household	1	1
$IADJ$	Investment adjustment factor	1	
PA_a	Activity price (unit gross revenue)	10	
PD_c	Supply price for commodity c produced and sold domestically	10	
PE_c	Export price for commodity c (in domestic currency)	8	
PM_c	Import price for commodity c (in domestic currency)	6	
PQ_c	Composite commodity price paid by domestic demanders	10	
PVA_a	Value-added price	10	
PX_c	Aggregate producer price for commodity c	10	
$PXAC_{a,c}$	Producer price of commodity c produced by activity a	100	
QA_a	Value added by activity	10	
$QC_{c,i}$	Quantity consumed of commodity c by institution i	100	10
QD_c	Quantity sold domestically of domestic output	10	
QE_c	Quantity of exports of commodity c	8	
$QF_{f,a}$	Quantity demanded of factor f by activity a	90	
QFS_f	Quantity supplied of factor f	9	9
QFU_f	Quantity unemployed of factor f	9	9
QIA_a	Activity investment	10	
$QINT_{c,a}$	Intermediate demand for commodity c from activity a	100	
$QINV_c$	Quantity of investment demand for commodity c	10	
QM_c	Quantity of imports for commodity c	6	
QQ_c	goods supplied to domestic market (composite. supply)	10	
QX_c	Aggregate quantity of domestic output of commodity c	10	
$QXAC_{a,c}$	Quantity of output of commodity c from activity a	100	
$TR_{i',i}$	Transfer from institution i to institution i'	121	40
$WALR$	The Walrasian, Saving-Investment balance is equal to zero	1	
WF_f	Price of factor f	9	
$WFDIST_{f,a}$	Price distortion for factor f in activity a	90	90
Y_i	Income of institution i	10	
YF_f	Income of factor f	9	
$YIF_{i,f}$	Income of institution i from factor f	99	9
Total number of variables		**1012 of which 172 are exogenous**	

Total number of equations required: 1012-172 = 840

A5 Balancing the Model by Exogenising

Eq. No.	No of Eqs.	Adjusted No. of Eqns.	Variables	No. of Vars	No. of exog. vars	Other Comments
1	10	10	CPI	1	1	By definition, as there is no money in the model
2	90	78	$DSAV_i$	10		Does not apply to ROW (R)
3	10	10	$ESADJ$	1		Allowed to vary
4	10	10	$EXPE_i$	10	1	as $EXPE$ = 0 for E & does not apply to ROW (R)
5	100	100	EXR	1		Allowed
6	10	10	$FSAV$	1	1	Assumed (EXR to adjust)
7	100	100	$GADI$	1	1	Assumed
8	10	10	$HSADJ$	1	1	Assumed ($IADJ$ to vary)
9	100	100	$IADJ$	1		Allowed to vary
10	8	8	PA_a	10		
11	8	8	PD_c	10		
12	2	2	PE_c	8		
13	8	8	PM_c	6		
14	8	8	PQ_c	10		
15	2	2	PVA_a	10		
16	6	6	PX_c	10		
17	6	6	$PXAC_{a,c}$	100		
18	4	4	QA_a	10		
19	6	6	$QC_{c,i}$	100	10	$QC_{c,i}$ = 0 for E & does not apply to R
20	6	6	QD_c	10		
21	4	4	QE_c	8		
22	9	9	$QF_{f,a}$	90	90	12 of which are zero (see equation 2 above)
23	90	90	QFS_f	9	9	By definition (no growth or migration)
24_1	9	9	QFU_f	9	9	Assumed
24_2	1	1	QIA_a	10		
25_1	9	9	$QINT_{c,a}$	100		
25_2	1	1	$QINV_c$	10		
25_3	1	1	QM_c	6		
26_1	8	8	QQ_c	10		
26_2	1	1	QX_c	10		
27	80	80	$QXAC_{a,c}$	100		
28	10	10	$TR_{i,i'}$	121	40	+52 equations from equation 35 are treated as exogenous
29	10	10	$WALR$	1		
30	10	10	WF_f	9	9	
31	9	9	$WFDIST_{f,a}$	90	90	Assumed, allowing markets to clear
32	1	1	Y_i	10		
33	1	1	YF_f	9		
34	1	1	$YIF_{i,f}$	99	9	Assumed, factor income to the rest of the world assumed exogenous
35	81	29				
Total	*840*	*776*		*1012*	*172*	*236 =172+12+52*
Balancing			***840 = 1012-172***		***776 = 1012-236***	

Appendix B

B1 GAMS Code for the CGE Model for Uganda (*CGE_UGA1*)

*===========**Basic Model Features**============

**Small open economy with no market power in world markets*

*10 goods, 10 activities, 8 exportables, 6 importables

*9 factors: 8 labour types, 1 capital

*11 institutions: 8 household types, 1 enterprise, 1 government, 1 rest of the world

*1 savings-investment account.

*===============**Sets are Defined as in Appendix A1**=========

*==

```
15  AC          "The global set including all items"
     /
17  AGRI_A      "Agriculture, fishing and forestry activity"
18  MIN_A       "Mining and quarrying activity"
19  PROC_A      "Food processing activity"
20  MAN_A       "Manufacturing activity"
21  ELEC_A      "Electricity and water service activity"
22  CONS_A      "Construction activity"
23  TRS_A       "Wholesale and retail trade activity"
24  TRAN_A      "Transportation and communication service activity"
25  HEAL_A      "Health and education activity"
26  OTH_A       "Other service activity"
29  AGRI_C      "Agricultural commodity"
30  MIN_C       "Mining and quarrying commodity"
31  PROC_C      "Food processing commodity"
32  MAN_C       "Manufacturing commodity"
33  ELEC_C      "Electricity and water service commodity"
34  CONS_C      "Construction commodity"
35  TRS_C       "Wholesale and retail trade commodity"
36  TRAN_C      "Transportation and communication service commodity"
37  HEAL_C      "Health and Education Service commodity"
38  OTH_C       "Other service commodity"
40  LS_RM       "Low skilled labour rural male"
41  LS_RF       "Low skilled labour rural female"
```

42 LS_UM "Low skilled labour urban male"
43 LS_UF "Low skilled labour urban female"
44 HS_RM "High skilled labour rural male"
45 HS_RF "High skilled labour rural female"
46 HS_UM "High skilled labour urban male"
47 HS_UF "High skilled labour urban female"
48 K "Capital"
50 CR_H "Central rural household"
51 CU_H "Central urban household"
52 ER_H "Eastern rural household"
53 EU_H "Eastern urban household"
54 NR_H "Northern rural household"
55 NU_H "Northern urban household"
56 WR_H "Western rural household"
57 WU_H "Western urban household"
59 E "Enterprise"
60 G "Government"
61 R "Rest of the world"
62 AC_TAX "Activity tax"
63 IM_TAX "Import tax"
64 VA_TAX "Value added tax"
65 S_I "Savings-investment"
67 TOTAL "Total account in the SAM"
/
*==========**Generating the Specific Sets and Sub-Sets**======
74 A (AC) "All Activities"
75 /AGRI_A, MIN_A, PROC_A, MAN_A, ELEC_A, CONS_A, TRS_A, TRAN_A, HEAL_A, OTH_ A/
77 C (AC) "All Commodities"
78 /AGRI_C, MIN_C, PROC_C, MAN_C, ELEC_C, CONS_C, TRS_C, TRAN_C, HEAL_C, OTH_ C/
80 CM(C) "Importables”
81 /AGRI_C, MIN_C, PROC_C, MAN_C, TRAN_C, OTH_C/
83 CNM(C) "Non-importables”
84 /ELEC_C, CONS_C, TRS_C, HEAL_C/

```
CE(C)    "Exportables”
 /AGRI_C, MIN_C, PROC_C, MAN_C, ELEC_C, TRS_C, TRAN_C,
OTH_C/
CNE(C)    "Non-exportables”
/CONS_C, HEAL_C/
F (AC)    "All Factors"
/LS_RM, LS_RF, LS_UM, LS_UF, HS_RM, HS_RF, HS_UM, HS_UF, K/

LAB (F)    "Labour"
/LS_RM, LS_RF, LS_UM, LS_UF, HS_RM, HS_RF, HS_UM, HS_UF/
I (AC)    "Institutions"
/CR_H, CU_H, ER_H, EU_H, NR_H, NU_H, WR_H, WU_H, E, G, R/
ID (I)   "Domestic Institutions"
/CR_H, CU_H, ER_H, EU_H, NR_H, NU_H, WR_H, WU_H, E, G/
 IDNG (ID) "Domestic non-government Institutions"
/CR_H, CU_H, ER_H, EU_H, NR_H, NU_H, WR_H, WU_H, E/

H (IDNG)      "Households"
/CR_H, CU_H, ER_H, EU_H, NR_H, NU_H, WR_H, WU_H/
ACNT (AC) “All elements in AC except total”;
*To exclude TOTAL from ACNT
ACNT (AC) = YES;
ACNT ('TOTAL') = NO;
;
*Alias sets to be used when we want to distinguish between two versions,
*when summing y (F, F) over columns, we can write SUM (F y (F, FAL))
ALIAS (AC, ACAL);
ALIAS (ACNT, ACNTAL);
ALIAS(C, CAL);
ALIAS (F, FAL);
ALIAS (I, IAL);
ALIAS (ID, IDAL);
ALIAS (IDNG, IDNGAL);
ALIAS (H, HAL);
ALIAS (A, AAL);
```

*================**Parameters Are Defined**======================
***==========as they appear in Appendix A2 and are Listed**
***============Alphabetically**============================

139 aac(C) "shift parameter for output aggregation function"

140 ava (A) "shift parameter for the CES activity production function"

141 aq(C) "shift parameter in CES aggregation for commodity C"

142 ax(C) "shift parameter in CES transformation for commodity C"

143 beta(C, H) "marginal share of consumption spending of commodity C by h'hold H"

144 cwts(C) "weight of commodity c in the CPI"

145 deltaac (A, C) "share parameter for output aggregation function"

146 deltava (F, A) "value added function share parameter for factor F in activity A"

147 deltaq(C) "share parameter for the composite good"

148 deltax(C) "share parameter for output transformation function"

149 hsdum (H) "0-1 dummy: 1 when saving changes, 0 otherwise"

150 ia (A) "quantity of investment I per unit of activity A"

151 ica(C, A) "quant of C used as an intermediate input per unit of activity A"

152 mps (IDNG) "initial marginal propensity to save by domestic non-government ins"

153 pwe (CE) "world export price in local currency units"

154 pwm (CM) "world import price in foreign currency units"

155 qg(C) "base year quantity of government demand for commodity C"

156 qinvi(C) "base year quantity of private investment demand for commodity C"

157 rhova (A) "exponent used in the value added activity production function"

158 rhoac(C) "exponent used in the output aggregation function"

159 rhoq(C) "exponent used in the Armington function for the composite good"

160 rhox(C) "exponent used in the transformation function for commodity C"

161 shinc (ID, F) "share for domestic institution I in the income of factor F"

162 shtr (ID, IAL) "share of income of domestic institution I in transfers from instn IAL"

163 sigmava (A) "elasticity of substitution for CES value added function for A"

164 sigmaac(C) "elasticity of substitution for CES aggregation of A into C"

165 sigmaq(C) "elasticity of substitution for the composite good C"

166 sigmax(C) "elasticity of substitution for CES transformation for C"

167 theta (A, C) "yield of commodity C per unit of activity A"

168 ta(A) "rate of activity tax"

169 te(CE) "rate of export tax"

170 tm(CM) "rate of import tax"

171 tq(C) "rate of sales tax"

172 ty(IDNG) "rate of direct income tax"

173;

*===

176***Variables Defined as in Appendix A4 and Listed Alphabetically**

*===

179 CPI "The consumer price index"

180 CPIH (H) "Consumer price index of household H"

181 DSAV (ID) "Domestic savings for institution I"

182 ESADJ "Savings adjustment variable for Enterprise"

183 EXPE (ID) "Expenditure by domestic institution I"

184 EXR "The exchange rate (local currency unit per unit of foreign currency”

185 FSAV "Foreign savings (Foreign currency units)"

186 GADJ "Government consumption adjustment factor"

187 HSADJ "Household savings adjustment factor"

188 IADJ "Investment adjustment variable"

189 PA (A) "Activity price (unit gross revenue)"

190 PD(C) "Supply price for commodity C produced and sold domestically”

191 PE (CE) "Export price for commodity C (domestic currency)"

192 PM (CM) "Import price for commodity C (domestic currency)"

193 PQ(C) "Composite commodity price paid by domestic demanders"

194 PVA (A) "Value added price for commodity C"

195 PX(C) "Aggregate producer price for commodity C"

196 PXAC (A, C) “Producer price for commodity C for activity A"

197 QA (A) "Quantity (level) of activity A"

198 QC(C, ID) "Quantity of commodity C consumed by domestic institution ID”

199 QD(C) "Quantity sold domestically of domestic output"

200 QE (CE) "Quantity of exports of commodity C"

201 QF (F, A) "Quantity demanded of factor F from activity A"

202 QFS (F) "Quantity supplied of factor F"

203 QIA (A) "Activity investment"

```
QINT(C, A)        "Quantity of commodity C as intermediate input to activity A”
QINV(C)           "Quantity of investment demand for commodity"
QM (CM)           "Quantity of imports for commodity C"
QQ(C)             "Quantity of goods supplied to domestic market"
QX(C)             "Aggregate quantity of domestic output of commodity"
QXAC (A, C)       "Quantity of output of commodity C from activity A"
TR (I, IAL)       "Transfers from other institution I to institution I"
WALR              "The Walrasian, Saving-Investment balance is equal to zero"
WF (F)            "Price of factor F"
WFDIST (F, A)     "Price distortion for factor F in activity A"
Y (ID)            "Income of domestic institution I"
YF (F)            "Income of factor F"
YIF (I, F)        "Income to institution I from factor F"
;
*=================================================
```

*Generating Parameters that hold the Calibrated Values of variables.**

***These parameters have the same name as the variables followed by a “0”**

```
*=================================================
PARAMETERS
CPI0              "Consumer price index"
CPIH0 (H)         "Consumer price index of household H"
DSAV0 (ID)        "Savings of domestic institutions"
ESADJ0            "Enterprise savings adjustment factor"
EXPE0 (ID)        "Expenditure of domestic institution i"
EXR0              "Exchange rate: domestic curr per unit of foreign currency”
FSAV0             "Foreign savings (in foreign currency units)"
GADJ0             "Government consumption adjustment factor"
HSADJ0            "Household savings adjustment factor"
IADJ0             "Investment adjustment factor"
PA0 (A)           "Activity price/gross revenue per activity unit"
PD0(C)            "Supply price of commodity C produced and sold domestically”
PE0 (CE)          "Export price for commodity C (in domestic currency units)”
PM0 (CM)          "Import price for commodity C (in domestic currency units)"
PQ0(C)            "Composite commodity price paid by domestic demanders"
```

```
PVA0 (A)          "Price of value added (factor income per unit of activity"
PX0(C)            "Aggregate commodity price for commodity C"
PXAC0 (A, C)      "Producer price of commodity C from activity A"
QA0 (A)           "Activity level/domestically produced output by activity A"
QC0(C, ID)        "Quantity consumed of commodity C by institution I"
QD0(C)            "Quantity sold domestically of domestic output"
QE0 (CE)          "Quantity of exports for commodity C"
QF0 (F, A)        "Quantity demanded of factor F by activity A"
QFS0 (F)          "Quantity supplied of factor F"
QIA0 (A)          "Quantity of investment I in activity A"
QINT0(C, A)       "Qty of commodity c as an intermediate input in activity A"
QINV0(C)          "Quantity of investment demand for commodity C"
QM0 (CM)          "Quantity of imports for commodity C"
QQ0(C)            "Qty of goods supplied to domestic market (comp. supply)"
QX0(C)            "Aggregate quantity of domestic output of commodity C"
QXAC0 (A, C)      "Quantity of output of commodity C from activity A"
TR0 (I, IAL)      "Transfer from institution I to other institution i"
WALR0             "Dummy variable (zero in equilibrium)"
WF0 (F)           "Price of factor F"
WFDIST0 (F, A)    "Wage distortion for factor F in activity A"
Y0 (ID)           "Income of domestic institution i"
YF0 (F)           "Income of factor F"
YIF0 (I, F)       "Income to domestic institution i from factor F"
;
*=====================Model Equations==================
*Equations Are Defined As They Appear In Appendix A3
*All Sets Are Specifically Defined
*Equations Are Numbered Sequentially
*=============================================
EQ1 (A)           "Activity value added production function"
EQ2 (F, A)        "Demand for factors by activities"
EQ3 (A)           "Activity investment (gross profit for activities)"
EQ4 (A)           "Zero profit condition"
EQ5(C, A)         "Quantity of commodity C as intermediate input to activity A"
EQ6 (A)           "Activity price or unit gross revenue"
EQ7 (A, C)        "Quantity of marketed output of commodity C from activity A"
```

```
EQ8(C)          "CES aggregation of activity production levels into commodity C"
EQ9 (A, C)          "First order condition for profit maximisation for QX"
EQ10 (CE)          "Export price (domestic currency) for commodity C"
EQ11 (CE)          "CES transformation of QD and QE into QX"
EQ12 (CNE)        "Transformation for non-exported commodity C"
EQ13 (CE)          "Export-domestic supply ratio for commodity C"
EQ14 (CE)          "Domestic value for exported and non-exported comm's"
EQ15 (CNE)        "Output value for non-exported commodity C"
EQ16 (CM)          "Import price for commodity C (domestic currency)"
EQ17 (CM)            "CES aggreg'n of QM and QD into QQ (composite supply)"
EQ18 (CNM)       "Composite version for non-imported commodity C"
EQ19 (CM)           "Import-domestic supply ratio for commodity C"
EQ20 (CM)           "Output value for composite supply of commodity C"
EQ21 (CNM)        "Output for non-imported commodity C"
EQ22 (F)              "Gross income of factor F"
EQ23 (ID, F)           "Disposable income to domestic institution i from factor F"
EQ24_1 (IDNG)    "Income of domestic non-government institution i"
EQ24_2               "Government revenue"
EQ25_1(IDNG)     "Budget constraint of Non-Gov't Institutions"
EQ25_2               "Expenditure by government"
EQ25_3               "Government budget constraint"
EQ26_1 (H)             "Marginal propensity to save adjustment for household H"
EQ26_2               "Marginal propensity to save adjustment for enterprise"
EQ27(C, H)           "consumption spending by household H on comm'ty C"
EQ28(C)              "Quantity of commodity C consumed by government"
EQ29(C)              "Quantity of fixed investment demand for commodity c"
EQ30(C)                 "Market equilibrium condition for composite commodity C"
EQ31 (F)             "Market equilibrium condition for factor F"
EQ32                 "Balance of payment condition, in foreign currency units"
EQ33           "Saving-investment balance with WALR dummy to be zero in eqm"
EQ34                        "The consumer price index (price normalization rule"
EQ35(IDNG,IDNGAL)      "Transfers between domestic non-gov'ntal instns"
 ;
```

***============The Social Accounting Matrix===========**

***The Social Accounting Matrix es presented in Appendix C1**

```
* and  es read by GAMS using the Code below.
*==================================================
313 TABLE SAM (AC, ACAL)
INCLUDE
  G:\KINGSTON FILES\CGE RESEARCH\Drake_GAMS\Uganda_SAM_V1.INC
316 * XLS2GMS 2.8 Nov 1, 2009 23.3.3 WIN 9600.15043 VIS x86/MS Windows
317 * Erwin Kalvelagen, GAMS Development Corp.
318 *==============================================
319 * Application: Microsoft Excel
320 * Version:     11.0
321 * Workbook:    G:\CGE RESEARCH\Drake_GAMS\Uganda_SAM_1.xls
322 * Sheet:     Sheet1
323 * Range:    $A$1:$AT$46
        ;
*=============================================
*Generating Total Column and Row for the SAM
*The following code checks consistency in the SAM.
* =============================================
PARAMETERS
ctotal1 (AC)   "column total, generated"
rtotal1 (AC)   "row total, generated"
ctotals (AC)   "column total, from SAM"
rtotals (AC)   "row total, from SAM"
diffc1s(AC)   "ctotal1 - ctotals"
diffr1s(AC)   "rtotal1 - rtotals"
tdiffscr (AC) "(column total - row total) for account AC in the SAM"
tdiff1cr (AC) "ctotal1 - rtotal1"
;
 ctotal1 (ACNT) = SUM (ACNTAL, SAM (ACNTAL, ACNT));
 rtotal1 (ACNT) = SUM (ACNTAL, SAM (ACNT, ACNTAL));
 ctotals (ACNT) = SAM ('TOTAL', ACNT);
 rtotals (ACNT) = SAM (ACNT,'TOTAL');
 diffc1s (ACNT) = ctotal1 (ACNT) - ctotals (ACNT);
 diffr1s (ACNT) = rtotal1 (ACNT) - rtotals (ACNT);
 tdiffscr (ACNT) = SAM ('TOTAL', ACNT) - SAM (ACNT,'TOTAL');
```

```
tdiff1cr (ACNT) = ctotal1 (ACNT) - rtotal1 (ACNT);
DISPLAY ctotal1, ctotals, rtotal1, rtotals,
      diffc1s, diffr1s, tdiffscr, tdiff1cr;
Display SAM;

*========Household Population Data==============
*Source: 2002/2003 Uganda National Household Budget Survey (UNHBS)
*Household data is measured in millions of households
*==============================================
PARAMETERS
NH (H)   "Number of different household types"
  /CR_H 1.0636, CU_H 0.6237, ER_H 1.1140, EU_H 0.1481,
   NR_H 0.7691, NU_H 0.0633, WR_H 1.0614, WU_H 0.1307 /
*========Labour Data============================
*Source: 2002/2003 Uganda National Household Survey
*Measured as number of employed workers
NWORKERS (LAB)   "Population of different labour types"
/LS_RM 3403842, LS_RF 4045634, LS_UM 527275, LS_UF 542754,
   HS_RM 353158, HS_RF 177366, HS_UM 127725, HS_UF 78246 /
*==========================================
*Parameter Values for the Elasticities in CES and CET Functions
*==========================================
* Source: Thurlow, J. (2008). A 2007 Agriculture focused Social Accounting
* Matrix for Uganda: International Food Policy Research Institute, Washington,
* D.C.
* Thurlow, J. (2005).A Recursive Dynamic Computable General Equilibrium
* Model for South Africa: Trade and Industrial Policy Strategies, Washington,
   D.C
* Nabil, Cockburn, and Decaluwe (2006). Functional Forms and
 *Parameterisation of CGE Models. MPIA Working Paper 2004-6.
*
*==============================================
Table EOS1 (*, C)
       AGRI_C  MIN_C  PROC_C  MAN_C  ELEC_C  CONS_C  TRS_C  TRAN_C  HEAL_C  OTH_C
  R1   2.5     0.9    2.0     3.8    2.8     1.9     1.9    1.9     1.9     1.9
  R2   1.898   4.01   1.37    1.5    1.6     1.5     1.5    1.696   1.5     1.5
  R3   1.9     0.9    2.0     3.8    2.8     1.9     1.9    1.9     1.9     1.9
  R4   0.5     0.8    0.5     2.0    2.0     2.0     2.0    1.5     2.0     2.0
;
sigmaq(C) = EOS1 ('R1', C);
```

411 sigmaac(C) = EOS1 ('R2', C);

412 sigmax(C) = EOS1 ('R3', C);

414 rhoq(C) = (1/sigmaq(C))-1;

415 rhoac(C) = (1/sigmaac(C))-1;

416 rhox(C) = (1/sigmax(C)) +1;

417 Display rhoq, rhoac, rhox;

414 rhoq(C) = (1/sigmaq(C))-1;

415 rhoac(C) = (1/sigmaac(C))-1;

416 rhox(C) = (1/sigmax(C)) +1;

417 Display rhoq, rhoac, rhox;

419 Table EOS2 (*, A)

420		AGRI_A	MIN_A	PROC_A	MAN_A	ELEC_A	CONS_A	TRS_A	TRAN_A	HEAL_A	OTH_A
421	R5	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0

423;

424 sigmava (A) = EOS2 ('R5', A);

425 rhova (A) = (1/sigmava (A))-1;

426 Display rhova;

*===

***========Adjusting Savings to Finance Investment========**
*choosing households whose savings must adjust to finance investment
* If savings is investment driven, savings dummy = 0 if no change and 1 if there is
* adjustment.
* For example*:* *if* household savings dummy (*hsdum*$_{i}$) which assumes a value of 1 *when saving is endogenous, *HSADJ*= 0; and D1=1 implies all households adjust their savings to finance investment.
428 Table SDUM_TAB (*, H)

429		CR_H	CU_H	ER_H	EU_H	NR_H	NU_H	WR_H	WU_H
430	D1	1	1	1	1	1	1	1	1
431	D2	1	1	0	0	0	0	1	1
432	D3	0	1	0	1	0	1	0	1
433	D4	0	0	0	0	0	0	0	0

434;

*============**All Households Adjust their Savings**=======

436 hsdum (H) = SDUM_TAB ('D1', H);

*===

*===============**Calibrating the Model**================

* ==================**Calculating Tax Rates**=============

```
439 ta (A) = SAM ('AC_TAX', A)/SAM ('TOTAL', A);
440 tm (CM) $(SAM ('R', CM)>0) = SAM ('IM_TAX', CM)/SAM ('R', CM);
441 tm (CM) $(SAM ('R', CM) =0) = 0;
442 te (CE) =0;
443 Display ta, te, tm;
*==================================================
444*====Defining Factor Wages and Factor Quantities=====
*==================================================
449 WF0 (F) = 1;
450 QFS0 (LAB) = NWORKERS (LAB);
455 QFS0 ('K') = SUM (A, SAM ('K', A));
456  QF0(F,A) = QFS0(F)*SAM(F,A)/SUM(AAL,SAM(F,AAL));
458  WFDIST0(F,A)$(QF0(F,A)>0) = SAM(F,A)/(WF0(F)*QF0(F,A));
459 WFDIST0 (F, A) $(QF0 (F, A) =0) = 0;
461 DISPLAY QF0, QFS0, WF0, WFDIST0;
 463 PARAMETER COSTGAP (F, A);
464 *Checking the consistency in total factor income/value added
465  COSTGAP(F,A) = WF0(F)*WFDIST0(F,A)*QF0(F,A) - SAM(F,A);
466 DISPLAY COSTGAP;
469*==============Fixing Initial Commodity Prices======
471 EXR0     = 1;
472 PA0 (A)   = 1;
473 PD0(C)   = 1;
474 PE0 (CE) = 1;
475 PM0 (CM) = 1;
476 PX0(C)   = 1;
477 pwe (CE) = PE0 (CE)/ ((1+te (CE))*EXR0);
478 pwm (CM) = PM0 (CM)/ ((1+tm (CM))*EXR0);
479 DISPLAY pwe, pwm;
*==================================================
481 tq(C) = SAM ('VA_TAX', C)/
        (SUM(A,SAM(A,C))-
        SAM(C,'R')+SAM('R',C)+SAM('IM_TAX',C)+SAM('VA_TAX ',C));
483 PQ0(C) = 1/ (1-tq(C));
484 QQ0(C) =SUM (A, SAM (A, C)) - SAM(C,'R')
```

```
                  + SAM ('R', C) + SAM ('IM_TAX', C);
DISPLAY tq, PQ0, QQ0;
QA0 (A) = SAM ('TOTAL', A)/PA0 (A);
QINT0(C, A) = SAM(C, A)/PQ0(C);
ica(C, A) = QINT0(C, A)/QA0 (A);
QIA0 (A) = SAM ('S_I', A)/PA0 (A);
ia (A) = QIA0 (A)/QA0 (A);
PVA0 (A) = (1- ta (A) - ia (A))*PA0 (A) - SUM(C, PQ0(C)*ica(C, A));
DISPLAY QA0, PVA0, QINT0, QIA0, ica, ia;

*==== checking for consistency in value added price========
PARAMETER PVA01, DIF01 (A);
PVA01 (A) = SUM (F, SAM (F, A))/QA0 (A);
DIF01 (A) =PVA01 (A)-PVA0 (A);
DISPLAY DIF01;
*================================================
PXAC0 (A, C) =1;
QXAC0 (A, C) = SAM (A, C)/PXAC0 (A, C);
theta (A, C) = (SAM (A, C)/PX0(C))/QA0 (A);
DISPLAY theta, QXAC0;
*=======aggregate output, exports, imports, and domestic sales==========
QX0(C) = SUM (A, SAM (A, C))/PX0(C);
QD0(C) = (SUM (A, SAM (A, C)) - SAM(C,'R'))/PD0(C);
QE0 (CE) = SAM (CE,'R')/PE0 (CE);
QM0 (CM) = (SAM ('R', CM) + SAM ('IM_TAX', CM))/PM0 (CM);
DISPLAY QX0, QD0, QE0, QM0;
*=================================================
*Fixing function exponents and share parameters for CES and CET functions
*=================================================
deltax (CE) =1/ (1+ ((QE0 (CE)/
                    QD0 (CE)) ** (rhox (CE)-1))*(PD0 (CE)/PE0 (CE)));
ax (CE) = QX0 (CE)/
  ((deltax(CE)*(QE0(CE)**rhox(CE))+(1-eltax(CE))*(QD0(CE)**rhox(CE)) )
                            ** (1/rhox (CE)));
DISPLAY deltax, ax;
```

```
521 deltaq (CM) =1/ (1+ ((QD0 (CM)/
                    QM0 (CM)) **(1+rhoq (CM)))*(PD0 (CM)/PM0 (CM)))  );
523 aq (CM) = QQ0 (CM)/
524   ((deltaq (CM)*(QM0 (CM) **(-rhoq (CM))) +
               (1-deltaq (CM))*(QD0 (CM) ** (- rhoq (CM)))) ** (-1/rhoq (CM)));
526 DISPLAY deltaq, aq;
528  deltava(F,A) = (WFDIST0(F,A)*WF0(F)*( QF0(F,A)**(1+rhova(A)) ))
    /SUM( FAL,WFDIST0(FAL,A)*WF0(FAL)*( QF0(FAL,A)**(1+rhova(A)) ) );
531 ava (A) = QA0 (A)/ ((SUM (F, deltava (F, A)*(QF0 (F, A)
                          ** (-rhova (A))))) ** (-1/rhova (A)));
532 DISPLAY deltava, ava;
542  deltaac(A,C)= ( PXAC0(A,C)*( QXAC0(A,C)**(1+rhoac(C)) ) )
543   /( SUM( AAL,PXAC0(AAL,C)*(QXAC0(AAL,C)**(1+rhoac(C))) ) );
545 aac(C)=QX0(C)/((SUM(A,deltaac(A,C)*(QXAC0(A,C)**(-rhoac(C)))))**(-
        1/rhoac(C)));
546 DISPLAY deltaac, aac;
 *==================================================
 *DISPLAYING FACTOR INCOME
549 PARAMETER YF01, DIFYF;
550 YF0 (F) = SAM ('TOTAL', F);
551  YF01(F) = SUM( A, WFDIST0(F,A)*WF0(F)*QF0(F,A) );

553*Checking consistency of factor incomes
554 DIFYF (F) =YF0 (F)-YF01 (F);
555 DISPLAY YF0, YF01, DIFYF;
*============================================
*FACTOR INCOME TO INSTITUTIONS AND SHARES
557 YIF0 (I, F) = SAM (I, F);
558 shinc (ID, F) = YIF0 (ID, F)/ (YF0 (F)-YIF0 ('R',F))
*================================================
*Incomes of domestic institutions. Note that diagonal transfers are excluded
*from household income.
*=================================================
561 *Y0 (H) = SAM ('TOTAL', H);
562 Y0 (H) = SAM ('TOTAL', H) - SAM (H, H);
```

```
Y0 ('E') = SAM ('TOTAL','E');
Y0 ('G') = SAM ('TOTAL','G');
ty (IDNG) = SAM ('G', IDNG)/Y0 (IDNG);
DISPLAY Y0, YIF0, shinc, ty;
*=====================================================
*Investment, Savings and Adjustment Factors for Institutions.
*Note the Explicit Definition of Savings
*=====================================================
DSAV0 (ID) = SAM ('S_I', ID);
mps (IDNG) = SAM ('S_I', IDNG)/ (Y0 (IDNG) - SAM ('G', IDNG));
ESADJ0 = 0;
 HSADJ0 = 0;
IADJ0 = 1;
DISPLAY mps, DSAV0;
QINV0(C) = SAM(C,'S_I')/PQ0(C);
qinvi(C) = QINV0(C);
DISPLAY qinvi;
*=====================================================
*Consumption of Commodities and Expenditures by
*Institutions
*=====================================================
beta(C, H) = SAM(C, H)/SUM (CAL, SAM (CAL, H));
QC0(C, ID) = SAM(C, ID)/PQ0(C);
qg(C) = QC0(C,'G');
EXPE0 (IDNG) = SUM(C, SAM(C, IDNG));
EXPE0 ('G') = SUM(C, SAM(C,'G'))
          + SUM (IDNG, SAM (IDNG,'G')) + SAM ('R','G');
DISPLAY QC0, beta, EXPE0;
*=====================================================
*Checking For Consistency in Government Budget
*Constraint
*=====================================================
PARAMETER GBS1, DIFGBS;
GBS1 = Y0 ('G') - EXPE0 ('G');
DIFGBS = GBS1-DSAV0 ('G');
```

```
DISPLAY DIFGBS;
GADJ0 = 1;
*==============The Consumer Price Index=============
 cwts(C)= SUM(H,SAM(C,H))/SUM((CAL,HAL),SAM(CAL,HAL));
CPI0 = SUM(C, cwts(C)*PQ0(C));
DISPLAY cwts, CPI0;
*=========Institutional Income Transfers===========
*note the specification of transfers note diagonal elements of the SAM are set to
*zero for households
*================================================
*TR0 (HAL, H) = SAM (HAL, H);
TR0(HAL,H)$(not diag(HAL,H)) = SAM(HAL,H)$(not diag(HAL,H));
TR0 (HAL, H) $(diag (HAL, H)) = 0;
TR0 (IDNG,'E') = SAM (IDNG,'E');
TR0 ('E', IDNG) = SAM ('E', IDNG);
shtr (IDNG, IDNGAL) = TR0 (IDNG, IDNGAL)
                  / ((1-ty (IDNGAL))*Y0 (IDNGAL) -DSAV0 (IDNGAL));
TR0 (IDNG,'G') = SAM (IDNG,'G')/CPI0;
TR0 ('R','G') = SAM ('R','G');
TR0 ('G','G') = SAM ('G','G');
TR0 (ID,'R') = SAM (ID,'R')/EXR0;
TR0 ('R', ID) = SAM ('R', ID);
TR0 ('R','R') = SAM ('R','R');
TR0 ('G', IDNG) = SAM ('G', IDNG);
DISPLAY shtr, TR0;
*================================================
*==============Foreign Savings and the Walras========
*Note FSAV is Defined As Inflow>0 in the SAM
*================================================
FSAV0 = - SAM ('R','S_I')/EXR0;
WALR0 = SUM (ID, DSAV0 (ID)) + EXR0*FSAV0 + SUM (A, SAM ('S_I', A))
       - SUM(C, PQ0(C)*QINV0(C));
PARAMETER WALR01, WALR02, WALR03, WALR04;
WALR01 = SUM (ID, DSAV0 (ID));
WALR02 = EXR0*FSAV0;
```

```
WALR03 = SUM (A, PA0 (A)*QIA0 (A));
WALR04 = SUM(C, PQ0(C)*QINV0(C));
DISPLAY WALR0, WALR01, WALR02, WALR03, WALR04;
*=====================================================
*Model Equations Defined as in Appendix A3
*=====================================================
EQ1 (A).. QA (A) =E= ava(A)*
  (( SUM( F, deltava(F,A)*( QF(F,A)**(-rhova(A)) )) ) **(-1/rhova(A)) );

EQ2 (F,A)$(QF0(F,A)>0)..  WFDIST (F, A)*WF (F)*(QF(F,A)**(1+rhova(A)))
           *(SUM( FAL, deltava(FAL,A)*( QF(FAL,A)**(-rhova(A)) )) )
         =E= deltava (F, A)*PVA (A)*QA (A);
EQ3 (A).. QIA (A) =E= ia(A)*QA(A);
EQ4 (A).. (1- ta(A) - ia(A))*PA (A) =E= PVA(A) + SUM( C, PQ(C)*ica(C,A) );
EQ5(C,A).. QINT(C, A) =E= ica(C,A)*QA(A);
EQ6(A).. PA(A) =E= SUM(C, theta(A,C)*PXAC(A,C));
EQ7(A,C)..QXAC(A,C) =E= theta(A,C)*QA(A);
EQ8(C).. QX(C) =E= aac(C)*
  (SUM(A, deltaac(A,C)*(QXAC(A,C)**(-rhoac(C))) ) )**(-1/rhoac(C));
EQ9 (A,C).. PXAC (A,C)*QXAC(A,C) =E= PX(C)*QX(C)*
          (deltaac(A,C)*(QXAC(A,C)**(-rhoac(C) ) ))
        /( SUM(AAL, deltaac(AAL,C)*(QXAC(AAL,C)**(-rhoac(C))) ) );
EQ10 (CE).. PE(CE) =E= (1+te(CE))*pwe(CE)*EXR;
EQ11 (CE).. QX(CE) =E= ax(CE)*
  (( deltax(CE)*(QE(CE)**rhox(CE) )
               + (1-deltax(CE))*(QD(CE)**rhox(CE)) )**(1/ rhox (CE))  );
EQ12 (CNE)..QX(CNE) =E= QD(CNE);

EQ13 (CE)..QE(CE)/QD(CE) =E=
  (  ( PE(CE)/PD(CE) ) * ( (1-deltax(CE))/deltax(CE) ) ) **(1/(rhox(CE)-1));
EQ14 (CE)..PX(CE)*QX(CE) =E= PD(CE)*QD(CE)+ PE(CE)*QE(CE);
EQ15 (CNE)..PX(CNE)*QX(CNE)=E= PD(CNE)*QD(CNE);
EQ16 (CM)..PM(CM) =E= (1+tm(CM))*pwm(CM)*EXR;
EQ17 (CM)..QQ (CM) =E= aq(CM)*( ( deltaq(CM)*(QM(CM)** (-rhoq(CM)))
         +(1-deltaq(CM))* (QD(CM)**(-rhoq(CM) )))**(-1/rhoq(CM)) );
```

```
EQ18(CNM)..QQ (CNM) =E= QD (CNM);
EQ19 (CM)..QM(CM)/QD(CM) =E=
  ( (PD(CM)/PM(CM))* (deltaq(CM)/(1-deltaq(CM))))** (1/ ( 1+rhoq(CM)));
EQ20 (CM)..PQ (CM)*(1-tq(CM))*QQ(CM)=E=
    PD(CM)*QD(CM)+PM(CM)*QM(CM);
EQ21 (CNM)..PQ(CNM)*(1-tq(CNM))*QQ(CNM) =E= PD(CNM)*QD(CNM);
EQ22(F)..YF(F) =E= SUM (A, WFDIST (F,A)*WF(F)*QF(F,A) );
EQ23 (ID, F)..YIF (ID, F) =E= shinc(ID, F)*(YF(F)-YIF('R',F));
EQ24_1(IDNG)..Y(IDNG) =E= SUM( F, YIF(IDNG,F))
                  + SUM(IDNGAL, TR(IDNG, IDNGAL))
                  + TR(IDNG, 'G')*CPI
                  + TR(IDNG, 'R')*EXR;
EQ24_2..Y('G') =E= SUM( F,YIF('G',F) )
              + SUM ( IDNG, ty(IDNG)*Y(IDNG))
              + SUM(C, tq(C)*PQ(C)*QQ(C) )
              + SUM( A, ta(A)*PA(A)*QA(A) )
              + SUM(CM, tm(CM)*EXR*pwm(CM)*QM(CM))
        + SUM (CE, te(CE)*EXR*pwe(CE)*QE(CE))+ TR('G','R')*EXR;
EQ25_1(IDNG)..DSAV(IDNG)+EXPE(IDNG)+SUM(IDNGAL, TR(IDNGAL,
    IDNG)) + TR('R', IDNG)  =E=  (1-ty(IDNG))*Y(IDNG);
EQ25_2..EXPE('G') =E= SUM( C, PQ(C)*QC(C,'G') )
               + SUM(IDNG, TR(IDNG, 'G')*CPI )
               + TR('R', 'G');
EQ25_3..DSAV('G') + EXPE('G') =E= Y('G') ;
EQ26_1(H).. mps(H)*(1 + hsdum(H)*HSADJ)*(1-ty(H))*Y(H) =E= DSAV(H);
EQ26_2.. mps('E')*(1 + ESADJ)*(1-ty('E'))*Y('E') =E= DSAV('E');
EQ27(C, H)..PQ(C)*QC(C,H) =E= beta(C,H)*EXPE(H);

EQ28(C)..QC(C,'G') =E= qg(C)*GADJ;
EQ29(C)..QINV(C) =E= qinvi(C)*IADJ;
EQ30(C)..QQ(C) =E= SUM (A, QINT(C,A))+ SUM(ID,QC(C,ID)) + QINV(C);
EQ31 (F).. SUM (A, QF (F,A))=E= QFS(F);
EQ32.. SUM (F, YIF('R',F))/EXR  + SUM (ID, TR('R', ID))/EXR
      + SUM (CM, pwm (CM)*QM (CM)) =E= SUM (CE, pwe(CE)*QE(CE))
       + SUM(ID, TR(ID, 'R')) + FSAV ;
```

```
EQ33..WALR=E=SUM (ID, DSAV(ID))+EXR*FSAV
                    +SUM (A, PA(A)*QIA(A))- SUM(C, PQ(C)*QINV(C));
EQ34.. CPI =E= SUM(C, cwts(C)*PQ(C) );
EQ35 (IDNG, IDNGAL) $(shtr(IDNG, IDNGAL)>0).. TR(IDNG, IDNGAL)
                              =E=
     shtr(IDNG,IDNGAL)*((1-ty(IDNGAL))*Y(IDNGAL)- DSAV(IDNGAL));
*=================================================
*==========Defining the Model to Be Solved===========
 * This attribute tells GAMS to generate and send to the solver all the variables.
 *================================================
MODELS MOD0 "base" /ALL/;
 *====================Initialisation================
*we first initialise the endogenous variables that do not appear in closures.
DSAV.L(ID) = DSAV0(ID);
ESADJ.L = ESADJ0;
EXPE.L(H) = EXPE0(H);
EXPE.L('G') = EXPE0('G');
HSADJ.L = HSADJ0;
PA.L(A) = PA0(A);
PD.L(C)= PD0(C);
PE.L(CE) = PE0(CE);
PM.L(CM) = PM0(CM);
PQ.L(C) = PQ0(C);
PVA.L(A)= PVA0(A);
PX.L(C) = PX0(C);
PXAC.L(A,C) = PXAC0(A,C);
QA.L(A) = QA0(A);
QC.L(C,'G')= QC0(C,'G');
QC.L(C,H)= QC0(C,H);
QD.L(C) = QD0(C);
QE.L(CE) = QE0(CE);
QINT.L(C,A)= QINT0(C,A);
QINV.L(C)= QINV0(C);
QIA.L(A)= QIA0(A);
QM.L(CM) = QM0(CM);
```

```
QQ.L(C)= QQ0(C);
QX.L(C) = QX0(C);
QXAC.L (A,C)= QXAC0(A,C);
WALR.L = WALR0;
Y.L(ID) = Y0(ID);
YF.L(F) = YF0(F);
YIF.L (ID,F) = YIF0(ID,F);
*==================Specifying the Closure Rules========
* The choice of Closure rules and their policy implications to Uganda are discussed in
* Appendix B2.
*The GAMS CODES of various closures are also stated in appendix *B2.
* We first specify those that are kept intact with exogenous variables.
CPI.FX  = CPI0;
YIF.FX('R',F) = YIF0('R',F);
TR.L(IDNG,IDNGAL)$(shtr(IDNG,IDNGAL)>0) = TR0(IDNG,IDNGAL);
TR.FX(IDNG,IDNGAL)$(shtr(IDNG,IDNGAL)=0) = TR0(IDNG,IDNGAL);
TR.FX('R',ID)= TR0('R',ID);
TR.FX(H,'R') = TR0(H,'R');
TR.FX('G','R')= TR0('G','R');
TR.FX('E','R')= TR0('E','R');
TR.FX('R','R') = TR0('R','R');
TR.FX(IDNG,'G') = TR0(IDNG,'G');
TR.FX('G','G') = TR0('G','G');
TR.FX('R','G')= TR0('R','G');
TR.FX('G','G') = TR0('G','G');
QC.FX(C,'E')= QC0(C,'E');
EXPE.FX('E') = EXPE0('E');
*==================================================
*Shocking Government Expenditure, EXPE(G)
GADJ.FX = 1.0*GADJ0;
*==================================================
*============Savings-Investment Closure================
*=====Savings is Investment Driven (SICLOS1).
*===================================================
```

*Under this closure, the total value of savings is determined by the total value of

*investment.

*In the model for Uganda, the marginal propensity to save is endogenous, and to

*finance investment, we choose those institutions whose savings adjust via the

*household savings dummy ($hsdum_i$) which assumes a value of 1 when saving is

*endogenous and zero when saving is exogenous.

*The household savings adjustment variable, _HSADJ_ is zero when saving is

*endogenous and 1 when savings is exogenous

*The household saving dummy takes a value of one for all selected institutions, and

*The household adjustment variable, _HSADJ_ is flexible, allowing savings of those

*institutions to adjust to finance investment

*The activity value of the household saving adjustment variable, _HSADJ_ is set to its

*base value.

*Investment is fixed through the investment adjustment variable to its base value.

ESADJ.L = 1.0*ESADJ0;

IADJ.FX = 1.0*IADJ0;

HSADJ.UP= +INF;

HSADJ.LO = -INF;

HSADJ.L = 1.0*HSADJ0;

*============**Exchange Rate Closure, _EXCLOS_**=============

*The exchange rate can be fixed or flexible controlled by _EXCLOS1_ and _EXRCLOS2_

*_EXRCLOS1_: Fixed Foreign Savings, Flexible Exchange Rate

*The policy implications of this closure are: First, Uganda cannot increase the size of

*its foreign debt and any additional increase in imported goods and services must be

*financed by additional export earnings.

*With _EXRCLOS1_, the exchange rate, _EXR_ is allowed to vary to clear any deficit on

*the current account.

*Foreign savings, _FSAV_ is fixed at its base level.

*The exchange rate, _EXR_ is allowed to vary to clear any deficit or surplus on the

*current account.

*The activity level of the exchange rate, _EXR_ is set at the base level.

FSAV.FX = FSAV0;

EXR.L = EXR0;

EXR.LO = -INF;

825 EXR.UP = +INF;

*===========**Factor Market Closure Rules**=============

*All choices of factor market closures are provided in appendix B2

* There are two factors of production: Capital and Labour. Labour is further classified

* as Low Skilled and High Skilled, Male or Female, Urban or Rural.

*All factors can be fully employed and mobile.

*=========**All Factors Are Mobile and Fully Employed**===

*A unique wage, *WF(F)* adjusts to clear the factor market.

*The wage distortion terms, *WFDIST (F,A)* for all factors in all activities are fixed.

*The activity level of the factor payment, *WF(F)* is set at the base level.

*The quantity demanded of factor by all activities, *QF(F,A)* is flexible.

*The current level of factor demanded by all activities, *QF(F,A)* is set at the base *level.

*There is no unemployed factor and the quantity of unemployed factor, *QFU(F)* is *fixed.

*QFS.FX(F)= QFS0(F);

*QF.FX(F,A) $(QF0(F,A)=0)= QF0(F,A);

*QF.L(F,A)$(QF0(F,A)>0) = QF0(F,A);

*WF.L(F)= WF0(F);

*WF.LO(F) = -INF;

*WF.UP(F) = +INF;

*WFDIST.FX (F,A) $(QF0 (F,A)=0)= WFDIST0(F,A);

*WFDIST.FX(F,A)$(QF0(F,A)>0)= WFDIST0 (F,A);

*==

*======**Factor Market Closure For the Uganda Model**=======

*==============***Closure For Capital***==================

****Capital is activity specific and fully employed, CAPCLOS2***

*The payment distortion factor for activity specific capital, WFDIST (‘K’, A) adjusts to clear the capital market.

*The current value of the payment distortion for activity specific capital, WFDIST (‘K’, A) is fixed at the base level.

*The payment for activity specific capital, WF(‘K’) is fixed at the base level.

*The quantity demanded of capital for each specific activity, QF(‘K’, A) is fixed at the base level.

*The activity level of unemployed activity specific capital, QFU(‘K’) is set at the is fixed at the base level.

861 WFDIST.LO('K',A) = -INF;

862 WFDIST.UP('K',A) = +INF;

863 WFDIST.L('K',A)= WFDIST0('K',A);

864 WF.FX('K') = WF0('K');

865 QF.FX('K',A)= QF0('K',A);

866 QFS.LO('K')= -INF;

867 QFS.UP('K') = +INF;

868 QFS.L('K') = QFS0('K');

*==

*===========**Labour Market Closures**=================

LABCLOS1: High Skilled Labour is Mobile and Fully Employed in All Activities

*==

*Policy implication: Shortage of skills especially high skilled labour in most *developing countries, Uganda inclusive (See Dorosh *et al*., 2002).

*4 types of high skilled labour: male or female, rural or urban

*The wage distortion term for each type of High Skilled labour,

**WFDIST (‘HS_LAB’, A)* in all activities is fixed.

*A unique wage for each type of skilled labour, *WF(‘HS_LAB’)* adjusts to clear the

*market for High Skilled labour

*The activity level of the wage, *WF(‘HS_LAB’)* for each type of High skilled labour

*is set at the base level.

*The quantity demanded of each type of High Skilled labour, *QF (‘HS_LAB’, A)* by

*all activities is allowed to vary.

*The current level of High Skilled labour demanded by all activities,

*Q*F(‘HS_LAB’, A)* is set at the initial/base level.

*The quantity of unemployed for all categories of High Skilled labour,

**QFU(‘HS_LAB’)* is set at the base level.

869 WFDIST.FX('HS_RM',A)$(QF0('HS_RM',A)>0)= WFDIST0('HS_RM',A);

870 WFDIST.FX('HS_RF',A)$(QF0('HS_RF',A)>0)= WFDIST0('HS_RF',A);

871 WFDIST.FX('HS_UM',A)$(QF0('HS_UM',A)>0)= WFDIST0('HS_UM',A);

872 WFDIST.FX('HS_UF',A)$(QF0('HS_UF',A)>0)= WFDIST0('HS_UF',A);

873 WF.LO('HS_RM') = -INF;

874 WF.UP('HS_RM') = +INF;

```
WF.LO('HS_RF') = -INF;
WF.UP('HS_RF') = +INF;
WF.LO('HS_UM') = -INF;
WF.UP('HS_UM') = +INF;
WF.LO('HS_UF') = -INF;
WF.UP('HS_UF') = +INF;
WF.L('HS_RM') = WF0('HS_RM');
WF.L('HS_RF') = WF0('HS_RF');
WF.L('HS_UM') = WF0('HS_UM');
WF.L('HS_UF') = WF0('HS_UF');
QF.LO('HS_RM',A) = -INF;
QF.LO('HS_RF',A) = -INF;
QF.LO('HS_UM',A) = -INF;
QF.LO('HS_UF',A) = -INF;
QF.UP('HS_RM',A) = +INF;
QF.UP('HS_RF',A) = +INF;
QF.UP('HS_UM',A) = +INF;
QF.UP('HS_UF',A) = +INF;
QF.FX('HS_RM',A)$(QF0('HS_RM',A)=0)= QF0('HS_RM',A);
QF.FX('HS_RF',A)$(QF0('HS_RF',A)=0)= QF0('HS_RF',A);
QF.FX('HS_UM',A)$(QF0('HS_UM',A)=0)= QF0('HS_UM',A);
QF.FX('HS_UF',A)$(QF0('HS_UF',A)=0)= QF0('HS_UF',A);
QF.L('HS_RM',A)$(QF0('HS_RM',A)>0)= QF0('HS_RM',A);
QF.L('HS_RF',A)$(QF0('HS_RF',A)>0)= QF0('HS_RF',A);
QF.L('HS_UM',A)$(QF0('HS_UM',A)>0)= QF0('HS_UM',A);
QF.L('HS_UF',A)$(QF0('HS_UF',A)>0)= QF0('HS_UF',A);
QFS.FX('HS_RM') = QFS0('HS_RM');
QFS.FX('HS_RF') = QFS0('HS_RF');
QFS.FX('HS_UM')= QFS0('HS_UM');
QFS.FX('HS_UF') = QFS0('HS_UF');
```

*==

***Closure for Low Skilled Labour, LABCLOS3**

*==

*Policy implication: Uganda like any developing economy has notable labour surplus *(unemployment) for Unskilled, Semi-skilled and Low Skilled labour. This means

*that the full employment closure may be unrealistic (Nganou, 2005; Dorosh *et al*.,
*2002).
*Four types of low skilled labour: male or female, rural or urban
*Low skilled labour is unemployed and mobile, LABCLOS3
*****The quantity of unemployed Low Skilled labour, *QFU('LS_LAB')* adjusts to clear the labour market
*The wage distortion factor for each type of Low Skilled labour in all activities,
**WFDIST('LS_LAB', A)* is fixed.
*The current level of the wage distortion for Low Skilled labour in all activities,
**WFDIST (LS_LAB, A)* is fixed at the base level.
*The wage for each type of Low Skilled labour, *WF('LS_LAB')* is fixed at the base
* level.
*The quantity demanded of each type of Low Skilled labour by all activities,
**QF('LS_LAB', A)* is flexible.
*The current level of each category of Low Skilled labour demanded by all activities,
**QF('LS_LAB', A)* is set at the initial/base level.
*The current level of each type of unemployed Low Skilled labour, *QFU('LS_LAB')*
* is set at the base level.

```
WFDIST.FX('LS_RM',A)$(QF0('LS_RM',A)>0)= WFDIST0('LS_RM',A);
WFDIST.FX('LS_RF',A)$(QF0('LS_RF',A)>0)= WFDIST0('LS_RF',A);
WFDIST.FX('LS_UM',A)$(QF0('LS_UM',A)>0)= WFDIST0('LS_UM',A);
WFDIST.FX('LS_UF',A)$(QF0('LS_UF',A)>0)= WFDIST0('LS_UF',A);
WF.FX('LS_RM') = WF0('LS_RM');
WF.FX('LS_RF') = WF0('LS_RF');
WF.FX('LS_UM') = WF0('LS_UM');
WF.FX('LS_UF') = WF0('LS_UF');
QF.LO('LS_RM',A) = -INF;
QF.UP('LS_RM',A) = +INF;
QF.LO('LS_RF',A) = -INF;
QF.UP('LS_RF',A) = +INF;
QF.LO('LS_UM',A) = -INF;
QF.UP('LS_UM',A) = +INF;
QF.LO('LS_UF',A) = -INF;
QF.UP('LS_UF',A) = +INF;
QF.FX('LS_RM',A)$(QF0('LS_RM',A)=0)= QF0('LS_RM',A);
```

```
QF.FX('LS_RF',A)$(QF0('LS_RF',A)=0)= QF0('LS_RF',A);
QF.FX('LS_UM',A)$(QF0('LS_UM',A)=0)= QF0('LS_UM',A);
QF.FX('LS_UF',A)$(QF0('LS_UF',A)=0)= QF0('LS_UF',A);
QF.L('LS_RM',A)$(QF0('LS_RM',A)>0)= QF0('LS_RM',A);
QF.L('LS_RF',A)$(QF0('LS_RF',A)>0)= QF0('LS_RF',A);
QF.L('LS_UM',A)$(QF0('LS_UM',A)>0)= QF0('LS_UM',A);
QF.L('LS_UF',A)$(QF0('LS_UF',A)>0)= QF0('LS_UF',A);
QFS.LO('LS_RM') = -INF;
QFS.UP('LS_RM') = +INF;
QFS.LO('LS_RF') = -INF;
QFS.UP('LS_RF') = +INF;
QFS.LO('LS_UM') = -INF;
QFS.UP('LS_UM') = +INF;
QFS.LO('LS_UF') = -INF;
QFS.UP('LS_UF') = +INF;
QFS.L('LS_RM') = QFS0('LS_RM');
QFS.L('LS_RF') = QFS0('LS_RF');
QFS.L('LS_UM') = QFS0('LS_UM');
QFS.L('LS_UF') = QFS0('LS_UF');
);
*==========END OF CLOSURE RULES======================
*=========PREPARING TO SOLVE AND REPORT==============
* we set up a loop for solution in which:
* the 1st item generates the base solution, and
* the 2nd item generates the solution for a given shock etc.
* we also decide what we want to report and generate it.
* sets and parameters for storing results and reporting them.

SETS
* Set Of Variable Solution to Be Displayed
REP "Set Of Variables to Be Reported: Base, Simulation, %Change"
   / BASE    "base simulation = calibrated values"
     SIM1   "solution from first simulation"
     PCHANGE "% change in the value of the variable wrt to 1st simulation"
*PCHANGE= 100*(SIM1-BASE)/BASE
```

```
*PCHANGE can only be displayed if BASE is positive
        /
*CASES FOR WHICH A SOLUTION IS TO BE OBTAINED IN THE LOOP

SOLU(REP) "SET OF SOLUTIONS: BASE, SIMULATION"
        /BASE     "base simulation = calibrated values"
         SIM    "e.g. a 50% decrease in import taxes"
        /
*=============================================
*Set of GDP Related Variables to be generated from Solution
*=============================================
 ACGDP "GDP COMPONENTS"
        /
        GDPFC     "GDP at factor prices"
        GDPGAP   "Gap btn alternative calculations for GDP at market prices"
        GDPMP1   "GDP at market prices (from spending side)"
        GDPMP2   "GDP at market prices (from income side)"
        GOVCON  "Government consumption"
        INVEST     "Investment"
        EXPOR      "Exports of goods and services"
        IMPOR      "Imports of goods and services"
        NITAX      "Net indirect taxes"
        PRVCON   "Private consumption"
        /
 ACGDP1 (ACGDP) "COMPONENTS OF GDP AT MARKET PRICES"
        /
         EXPOR       "Exports of goods and services"
         GOVCON   "Government consumption"
         IMPOR       "Imports of goods and services"
         INVEST     "Investment"
         PRVCON   "Private consumption"
        /
 ;
*=============================================
```

997 *VARIABLE VALUES TO BE USED FOR SOLUTION FOR BASE AND SIMULATION

*==

999 *examples of simulations

1000 TAR_CUT(CM, REP) "Decrease in import tariffs (an example)"

1001 *REMIT_INCR(H,REP) "Increase in migrant workers remittances"

1002 *PWE_INCR(CE,REP) "Increase in world export price”"

1003 *FSAV_INCR(REP) "Increase in foreign savings/FDI"

*==

1005 *SETTING THE BENCH AND SHOCKED CASES

*==

1006 *TAR_CUT(CM,'BASE')= tm(CM);

1007 *TAR_CUT(CM,'SIM')= 0.5*tm(CM);

1008 * REMIT_INCR(H,'BASE') = TR0(H,'R');

1009 *REMIT_INCR(H,'SIM') = 1.5*TR0(H,'R');

1010 *PWE_INCR(CE,'BASE') = PWE(CE);

1011 *PWE_INCR(CE,'SIM’) = 1.3*PWE(CE);

1012 *FSAV_INCR('BASE') = FSAV0;

1013 *FSAV_INCR('SIM’)= 1.4*FSAV0;

*===

1015*VARIABLE VALUES TO BE REPORTED FOR BASE AND SHOCKED *CASES

*===

1017 CPIREP(REP) "The consumer price index"

1018 DSAVREP(ID,REP) "Domestic savings for institution I"

1019 ESADJREP(REP) "Savings adjustment variable for Enterprise"

1020 EXPEREP(ID,REP) "Expenditure by domestic institution ID"

1021 EXRREP(REP) "The exchange rate (LCU per FCU)"

1022 FSAVREP(REP) "Foreign savings (Foreign currency units)"

1023 GADJREP(REP) "Government consumption adjustment factor"

1024 HSADJREP(REP) "Household savings adjustment factor"

1025 IADJREP(REP) "Investment adjustment variable"

1026 PAREP(A,REP) "Activity price(unit gross revenue)"

1027 PDREP(C,REP) "Supply price for com’dty C produced and sold domestically”

1028 PEREP(CE,REP) " Export price for commodity C (domestic currency)"

```
PMREP(CM,REP)       "Import price for commodity C (domestic currency)"
PQREP(C,REP)      "Composite commodity price paid by domestic demanders”
PVAREP(A,REP)        "Value added price for commodity C"
PXREP(C,REP)           "Aggregate producer price for commodity C"
PXACREP(A,C,REP)    "Producer price for commodity C for activity A"
QAREP(A,REP)        "Quantity (level) of activity A"
QCREP(C,ID,REP)  "Quantity of commod C consumed by domestic instit’n”
QDREP(C,REP)          "Quantity sold domestically of domestic output"
QEREP(CE,REP)        "Quantity of exports of commodity C"
QFREP(F,A,REP)       "Quantity demanded of factor F from activity A"
QFSREP(F,REP)         "Quantity supplied of factor F"
QIAREP(A,REP)        "Activity investment"
QINTREP(C,A,REP) "Quantity of commod C as intermediate input to activity”
QINVREP(C,REP)      "Quantity of investment demand for commodity"
QMREP(CM,REP)       "Quantity of imports for commodity C"
QQREP(C,REP)          "Quantity of goods supplied to domestic market"
QXREP(C,REP)           "Aggregate quantity of domestic output of commodity"
QXACREP(A,C,REP)   "Quantity of output of commodity C from activity A"
TRREP(I,IAL,REP)     "Transfers from other institution I to institution I"
WALRREP(REP)  "The Walrasian, Saving-Investment balance is equal to zero”
WFREP(F,REP)            "Price of factor F"
WFDISTREP(F,A,REP)   "Price distortion for factor F in activity A"
YREP(ID,REP)            "Income of domestic institution ID"
YFREP(F,REP)            "Income of factor F"
YIFREP(I,F,REP)         "Income to institution I from factor F"
GDPREP(ACGDP,REP)   "all GDP items"

*=====================================================
*WELFARE  AND  INEQUALITY VARIABLES
*=====================================================
UHREP(H,REP)      "Utility of household H"
CPIHREP(H,REP)   "Consumper price index of household H"
TLREP(REP)          "Theil-L index"
TTREP(REP)          "Theil-T index"
HIREP(REP)          "Hoover index"
```

```
1062  TSREP(REP)          "Theil-S index"
1063  WTLREP(REP)      "Welfare using Theil-L index"
1064  WTTREP(REP)      "Welfare function using Theil-T index"
1065  WHIREP(REP)       "Welfare function using the Hoover Index"
1066  ;
 *=====================================================
1068  *VARIABLE VALUES TO BE USED IN SOLUTION FOR BASE AND
        SIMULATION CASES: an example using TARIFF CUTS (TAR_CUT)
*=====================================================
1069  TARCUT (CM,'BASE') = tm(CM);
1070  TARCUT(CM,'SIM') = 0.5*tm(CM);
*****************************************************************
*****
*==================USING THE LOOP====================
1071*SOLVING FOR THE BASE AND SHOCKED CASES
1072 *THE LOOP BELOW RUNS OVER THE SET REP = {BASE, TARCUT}
      *AND FOR EACH SOLUTION STORES THE VALUES OF THE VARIABLES    AS
        REQUIRED.
*=====================================================
1076  LOOP(SOLU,
1079 TM (CM) = TAR_CUT(CM,SOLU);
*=====================================================
*INITIALISING ALL ENDOGENOUS VARIABLES
*=====================================================
1083  CPI.L =  CPI0                          ;
1084  DSAV.L(ID) = DSAV0(ID)        ;
1085  ESADJ.L =  ESADJ0                 ;
1086  EXPE.L(ID) = EXPE0(ID)         ;
1087  EXR.L = EXR0                         ;
1088  FSAV.L = FSAV0                     ;
1089  GADJ.L = GADJ0                     ;
1090  HSADJ.L =  HSADJ0               ;
1091  IADJ.L =  IADJ0                      ;
1092  PA.L(A) = PA0(A)                  ;
1093  PD.L(C) = PD0(C)                  ;
```

```
PE.L(CE) = PE0(CE)               ;
PM.L(CM) = PM0(CM)               ;
PQ.L(C) = PQ0(C)                 ;
PVA.L(A) = PVA0(A)               ;
PX.L(C) = PX0(C)                 ;
PXAC.L(A,C) = PXAC0(A,C)    ;
QA.L(A) = QA0(A)                 ;
QC.L(C,H) = QC0(C,H)             ;
QC.L(C,'G') = QC0(C,'G')         ;
QD.L(C) = QD0(C)                 ;
QE.L(CE) = QE0(CE)               ;
QF.L(F,A) = QF0(F,A)             ;
QFS.L(F) = QFS0(F)               ;
QIA.L(A) = QIA0(A)               ;
QINT.L(C,A) = QINT0(C,A)     ;
QINV.L(C) = QINV0(C)             ;
QM.L(CM) = QM0(CM)               ;
QQ.L(C) = QQ0(C)                 ;
QX.L(C) = QX0(C)                 ;
QXAC.L(A,C) = QXAC0(A,C)   ;
WALR.L = WALR0                   ;
WF.L(F) = WF0(F)                 ;
WFDIST.L(F,A) = WFDIST0(F,A)  ;
Y.L(ID) = Y0(ID)                 ;
YF.L(F) = YF0(F)                 ;
YIF.L(I,F) = YIF0(I,F)           ;

*===================Solving the Model==============
* ================and Storing the Solution============
*Use Hold Fix To Speed Up the Solution
*This Attribute Tells Gams whether to generate and send to the solver the variables that are being Held Fixed by the Command .FX.
*===============================================

MOD0.HOLDFIXED = 1;
OPTION MCP=path;
SOLVE MOD0 USING MCP;
```

```
*==============================================================
1131*=============VARIABLES TO BE STORED=============
1133  CPIREP(SOLU)= CPI.L              ;
1134  DSAVREP(ID,SOLU) = DSAV.L(ID)    ;
1135  ESADJREP(SOLU)= ESADJ.L          ;
1136  EXPEREP(ID,SOLU)= EXPE.L(ID)     ;
1137  EXRREP(SOLU)= EXR.L              ;
1138  FSAVREP(SOLU) = FSAV.L           ;
1139  GADJREP(SOLU) = GADJ.L           ;
1140  HSADJREP(SOLU)= HSADJ.L          ;
1141  IADJREP(SOLU) = IADJ.L           ;
1142  PAREP(A,SOLU) = PA.L(A)          ;
1143  PDREP(C,SOLU) = PD.L(C)          ;
1144  PEREP(CE,SOLU)= PE.L(CE)         ;
1145  PMREP(CM,SOLU)= PM.L(CM)         ;
1146  PQREP(C,SOLU) = PQ.L(C)          ;
1147  PVAREP(A,SOLU) = PVA.L(A)        ;
1148  PXREP(C,SOLU) =  PX.L(C)         ;
1149  PXACREP(A,C,SOLU)= PXAC.L(A,C)   ;
1150  QAREP(A,SOLU) = QA.L(A)          ;
1151  QCREP(C,ID,SOLU)= QC.L(C,ID)     ;
1152  QDREP(C,SOLU)= QD.L(C)           ;
1153  QEREP(CE,SOLU)= QE.L(CE)         ;
1154  QFREP(F,A,SOLU) = QF.L(F,A)      ;
1155  QFSREP(F,SOLU)= QFS.L(F)         ;
1156  QIAREP(A,SOLU)= QIA.L(A)         ;
1157  QINTREP(C,A,SOLU)= QINT.L(C,A)   ;
1158  QINVREP(C,SOLU)= QINV.L(C)       ;
1159  QMREP(CM,SOLU)=  QM.L(CM)        ;
1160  QQREP(C,SOLU) = QQ.L(C)          ;
1161  QXREP(C,SOLU)=  QX.L(C)          ;
1162  QXACREP(A,C,SOLU)= QXAC.L(A,C)   ;
1163  TRREP(I,IAL,SOLU)= TR.L(I,IAL)   ;
1164  WALRREP(SOLU)= WALR.L            ;
1165  WFREP(F,SOLU)= WF.L(F)           ;
```

```
WFDISTREP(F,A,SOLU)= WFDIST.L(F,A);
YREP(ID,SOLU)= Y.L(ID)          ;
YFREP(F,SOLU)= YF.L(F)          ;
YIFREP(I,F,SOLU)= YIF.L(I,F)    ;
*=====================================================
* CREATING AND PROCESSING THE GDP DATA
*AN EQUIVALENT OF THE NATIONAL INCOME TABLE
*=====================================================
GDPREP('PRVCON',SOLU) = SUM((C,H),PQ.L(C)*QC.L(C,H));
GDPREP('GOVCON',SOLU) = SUM(C, PQ.L(C)*QC.L(C,'G'));
GDPREP('INVEST',SOLU)= SUM(C, PQ.L(C)*QINV.L(C));
GDPREP('EXPOR',SOLU) = SUM(CE, EXR.L*PWE(CE)*QE.L(CE));
GDPREP('IMPOR',SOLU) = SUM(CM, EXR.L*PWM(CM)*QM.L(CM));
GDPREP('GDPFC',SOLU) =
                  SUM((F,A), WF.L(F)*WFDIST.L(F,A)*QF.L(F,A));
GDPREP('NITAX',SOLU)  = + SUM( C, tq(C)*PQ.L(C)*QQ.L(C) )
                   + SUM(CM, tm(CM)*EXR.L*PWM(CM)*QM.L(CM))
                   + SUM(CE, te(CE)*EXR.L*PWE(CE)*QE.L(CE));
*================================================
*Computing Utility, Inequality, and Welfare
*================================================
CPIHREP(H, SOLU) = PROD(C,(PQ.L(C))**beta(C,H) );
UHREP(H, SOLU) = PROD(C,(QC.L(C,H)/beta(C,H))**beta(C,H));
HIREP(SOLU)= 1/2*SUM(H,abs(Y.L(H)
                  /SUM(HAL,Y.L(HAL))-NH(H)/SUM(HAL,NH(HAL)) ) );
TLREP(SOLU) = log(SUM(H, Y.L(H))/SUM(H,NH(H)))
           -SUM (H, NH (H)*log (Y.L (H)/NH (H)))/SUM(HAL,NH(HAL));
TTREP(SOLU) = log(SUM(H,NH(H))/SUM(H, Y.L(H)))
                   -SUM(H,Y.L(H)*log(NH(H)/Y.L(H)))/SUM(HAL,Y.L(HAL));
TSREP(SOLU) = 1/2*SUM(H,log(Y.L(H)/NH(H))*(Y.L(H) /
             SUM(HAL,Y.L(HAL))-NH(H)/SUM(HAL,NH(HAL))));
WTLREP(SOLU) = ( SUM(H, Y.L(H)) /
                  SUM(H,NH(H) ) ) *(EXP(-TLREP(SOLU)));
WHIREP(SOLU) = ( SUM(H, Y.L(H)) /
                       SUM(H,NH(H) ) ) * (1-HIREP(SOLU)) ;
```

```
WTTREP(SOLU) = ( SUM(H,NH(H) ) /
                 SUM (H, Y.L(H)))* (EXP(-TTREP(SOLU)));
*=================================================
*================CALCULATING THE GDP GAP=========
*=================================================
GDPREP('GDPMP1',SOLU) = SUM(ACGDP, GDPREP(ACGDP,SOLU));
GDPREP('GDPMP2',SOLU) = GDPREP('GDPFC',SOLU)
                        +GDPREP('NITAX',SOLU);
GDPREP('GDPGAP',SOLU) = GDPREP('GDPMP1',SOLU)
                        - GDPREP('GDPMP2',SOLU);
*==================================================
*===============END OF LOOP=======================
 );
*=================================================
*=======Generating the percentage changes=========
*==================================================
CPIHREP(H,'PCHANGE')= 100*(CPIHREP(H,'SIM')
             -CPIHREP(H,'BASE'))
             /CPIHREP (H,'BASE');
DSAVREP(ID,'PCHANGE')$(DSAVREP(ID,'BASE')>0)
             = 100*(DSAVREP(ID,'SIM') - DSAVREP(ID,'BASE'))
             /DSAVREP(ID,'BASE');
EXPEREP(ID,'PCHANGE')$(EXPEREP(ID,'BASE')>0)
             = 100*(EXPEREP(ID,'SIM') - EXPEREP(ID,'BASE'))
             /EXPEREP(ID,'BASE');
EXRREP('PCHANGE')$(EXRREP('BASE')>0)
             = 100*(EXRREP('SIM') - EXRREP('BASE'))
             /EXRREP('BASE');
FSAVREP('PCHANGE')$(FSAVREP('BASE')>0)
             = 100*(FSAVREP('SIM') - FSAVREP('BASE'))
             /FSAVREP('BASE');
GDPREP(ACGDP,'PCHANGE')$(GDPREP(ACGDP,'BASE')>0)
             = 100*(GDPREP(ACGDP,'SIM')
               - GDPREP(ACGDP,'BASE')) /GDPREP(ACGDP,'BASE');
HIREP('PCHANGE') = 100*(HIREP('SIM') - HIREP('BASE'))
```

```
                    /HIREP('BASE');
IADJREP('PCHANGE') = 100*(IADJREP('SIM') - IADJREP('BASE'))
                    /IADJREP('BASE');
PAREP(A,'PCHANGE') = 100*(PAREP(A,'SIMU1') - PAREP(A,'BASE'))
                    /PAREP(A,'BASE');
PDREP(C,'PCHANGE') = 100*(PDREP(C,'SIMU1') - PDREP(C,'BASE'))
                    /PDREP(C,'BASE');
PEREP(CE,'PCHANGE')= 100*(PEREP(CE,'SIM') - PEREP(CE,'BASE'))
                    /PEREP(CE,'BASE');

PMREP(CM,'PCHANGE')= 100*(PMREP(CM,'SIM')
                    - PMREP(CM,'BASE'))
                    /PMREP(CM,'BASE');
PQREP(C,'PCHANGE') = 100*(PQREP(C,'SIM') - PQREP(C,'BASE'))
                    /PQREP(C,'BASE');
PVAREP(A,'PCHANGE')= 100*(PVAREP(A,'SIM')- PVAREP(A,'BASE'))
                   /PVAREP(A,'BASE');
PXREP(C,'PCHANGE') = 100*(PXREP(C,'SIM') - PXREP(C,'BASE'))
                    /PXREP(C,'BASE');
QAREP(A,'PCHANGE') = 100*(QAREP(A,'SIM') - QAREP(A,'BASE'))
                    /QAREP(A,'BASE');

QCREP(C,H,'PCHANGE')$(QCREP(C,H,'BASE')>0)
                  = 100*(QCREP(C,H,'SIM') - QCREP(C,H,'BASE'))
                    /QCREP(C,H,'BASE');
QCREP(C,'G','PCHANGE')$(QCREP(C,'G','BASE')>0)
                  = 100*(QCREP(C,'G','SIM') - QCREP(C,'G','BASE'))
                    /QCREP(C,'G','BASE');

QDREP(C,'PCHANGE')= 100*(QDREP(C,'SIM')- QDREP(C,'BASE'))
                    /QDREP(C,'BASE');

QEREP(CE,'PCHANGE')= 100*(QEREP(CE,'SIMU1') - QEREP(CE,'BASE'))
                    /QEREP(CE,'BASE');
QFREP(F,A,'PCHANGE')$(QFREP(F,A,'BASE')>0)
```

```
                 = 100*(QFREP(F,A,'SIM')
                     -QFREP(F,A,'BASE')) /QFREP(F,A,'BASE');

QFSREP(F,'PCHANGE')$(QFSREP(F,'BASE')>0)
                    = 100*(QFSREP(F,'SIM')
                     - QFSREP(F,'BASE')) /QFSREP(F,'BASE');
QINTREP(C,A,'PCHANGE')$(QINTREP(C,A,'BASE')>0)
                 = 100*(QINTREP(C,A,'SIM')
                   -QINTREP(C,A,'BASE')) /QINTREP(C,A,'BASE');
QINVREP(C,'PCHANGE')$(QINVREP(C,'BASE')>0)
                 = 100*(QINVREP(C,'SIM') - QINVREP(C,'BASE'))
                   /QINVREP(C,'BASE');
QIAREP(A,'PCHANGE')$(QIAREP(A,'BASE')>0)
       = 100*(QIAREP(A,'SIMU1')-QIAREP(A,'BASE')) /QIAREP(A,'BASE');
QMREP(CM,'PCHANGE')$(QMREP(CM,'BASE')>0)
                 = 100*(QMREP(CM,'SIM') - QMREP(CM,'BASE'))
                    /QMREP(CM,'BASE');
QQREP(C,'PCHANGE')$(QQREP(C,'BASE')>0)
                 = 100*(QQREP(C,'SIM') - QQREP(C,'BASE'))
                   /QQREP(C,'BASE');
QXREP(C,'PCHANGE')$(QXREP(C,'BASE')>0)
                  = 100*(QXREP(C,'SIM') - QXREP(C,'BASE'))
                   /QXREP(C,'BASE');
QXACREP(A,C,'PCHANGE')$(QXACREP(A,C,'BASE')>0)
                  = 100*(QXACREP(A,C,'SIM') - QXACREP(A,C,'BASE'))
                   /QXACREP(A,C,'BASE');
TLREP('PCHANGE')= 100*(TLREP('SIM')
                         -TLREP('BASE'))/TLREP('BASE');
TRREP(I,IAL,'PCHANGE')$(TRREP(I,IAL,'BASE')>0)
             = 100*(TRREP(I,IAL,'SIM') - TRREP(I,IAL,'BASE'))
               /TRREP(I,IAL,'BASE');
TSREP('PCHANGE') =100*(TSREP('SIM')
                          - TSREP('BASE'))/TSREP('BASE');
TTREP('PCHANGE') =100*(TTREP('SIM')
                           - TTREP('BASE'))/TTREP('BASE');
```

```
UHREP(H,'PCHANGE') =100*(UHREP(H,'SIM')
                                   -UHREP(H,'BASE'))/UHREP(H,'BASE; );
WALRREP('PCHANGE') $(WALRREP('BASE')>0)
                    = 100*(WALRREP('SIM') - WALRREP('BASE'))
                      /WALRREP('BASE');
WFREP(F,'PCHANGE')$(WFREP(F,'BASE')>0)
                    = 100*(WFREP(F,'SIM')
                         - WFREP(F,'BASE')) /WFREP(F,'BASE');
WFDISTREP(F,A,'PCHANGE')$(WFDISTREP(F,A,'BASE')>0)
                    = 100*(WFDISTREP(F,A,'SIM')
                     - WFDISTREP(F,A,'BASE'))/WFDISTREP(F,A,'BASE');
WHIREP('PCHANGE')= 100*(WHIREP('SIMU1')- WHIREP('BASE'))
                  /WHIREP('BASE');
WTLREP('PCHANGE')= 100*(WTLREP('SIMU1')- WTLREP('BASE'))
                  /WTLREP('BASE');
WTTREP('PCHANGE')= 100*(WTTREP('SIM')- WTTREP('BASE'))
                  /WTTREP('BASE');
YREP(ID,'PCHANGE')$(YREP(ID,'BASE')>0)
                    = 100*(YREP(ID,'SIM') - YREP(ID,'BASE'))
                         /YREP(ID,'BASE');
YFREP(F,'PCHANGE')$(YFREP(F,'BASE')>0)
                    = 100*(YFREP(F,'SIM')-YFREP(F,'BASE'))
                              /YFREP(F,'BASE');
YIFREP(I,F,'PCHANGE')$(YIFREP(I,F,'BASE')>0)
                    = 100*(YIFREP(I,F,'SIM') - YIFREP(I,F,'BASE'))
                      /YIFREP(I,F,'BASE');
;
*==================================================
*CALCULATING THE EQUIVALENT AND COMPENSATING VARIATION
*============WELFARE MEASURES======================
PARAMETERS
EV(H)      "Equivalent Variation of household H"
CV(H)      "Compensating Variation of household H"
TEV        "Economy wide EV"
TCV        "Economy wide CV"
```

```
;
CV(H) = EXPEREP(H,'SIM')-(CPIHREP(H,'SIM')
                    /CPIHREP(H,'BASE')) *EXPEREP(H,'BASE');
EV(H) = (CPIHREP(H,'BASE')
                  /CPIHREP(H,'SIM'))*EXPEREP(H,'SIM')
                   -EXPEREP(H,'BASE');
*=================================================
*COST OF WELFARE TO SOCIETY DUE TO EV AND CV
*=================================================
TCV= 100*(sum(H,CV(H))/sum(H,EXPEREP(H,'BASE')));
TEV= 100*(sum(H,EV(H))/sum(H,EXPEREP(H,'BASE')));
*================================================
*DISPLAYING THE BASE AND SHOCK SOLUTIONS, AND POST SHOCK
*PERCENTAGE CHANGES.
*=================================================
DISPLAY
CPIREP, CPI0,
DSAVREP,DSAV0,
ESADJREP, ESADJ0,
EXPEREP, EXPE0,
EXRREP, EXR0,
FSAVREP, FSAV0,
GADJREP, GADJ0,
GDPREP,
HSADJREP, HSADJ0,
IADJREP, IADJ0,
PAREP, PA0,
PDREP, PD0,
PEREP, PE0,
PMREP, PM0,
PQREP, PQ0,
PVAREP, PVA0,
PXREP, PX0,
PXACREP, PXAC0,
QAREP, QA0,
```

```
QCREP, QC0,
QDREP, QD0,
QEREP, QE0,
QFREP, QF0,
QFSREP, QFS0,
QINTREP, QINT0,
QINVREP, QINV0,
QIAREP, QIA0,
QMREP, QM0,
QQREP, QQ0,
QXREP, QX0,
QXACREP, QXAC0,
TRREP, TR0,
WHIREP,
WTLREP,
WTTREP,
WALRREP, WALR0
WFREP, WF0,
WFDISTREP, WFDIST0,
YREP, Y0,
YFREP, YF0,
YIFREP, YIF0,
CPIHREP,
HIREP,
TLREP,
TTREP,
TSREP,
UHREP,
EV,CV, TEV, TCV
;
```

B2 Choice of Closure Rules

Exchange Rate Closure (EXRCLOS)

- Exchanged rate can be fixed or flexible. This is controlled by *EXRCLOS1* and *EXRCLOS2*.

***EXRCLOS1*: Fixed Foreign Savings, Flexible Exchange Rate**

- The exchange rate is allowed to vary to clear any deficit on the current account.
- The policy implications of this closure are: First, Uganda cannot increase the size of its foreign debt and any additional increase in imported goods and services must be financed by additional export earnings.
- Secondly, this closure limits the degree of import competition in the domestic market but highlights the importance of an export led growth strategy through the promotion of Uganda's industrial and agricultural sectors. This is in line with the country's Poverty Reduction Strategy Paper (PRSP, 2010-2015).
- Several studies have adopted this closure in studying the impact of exogenous policy changes on Uganda's economy (Dorosh *et al*., 2009[43]; Thurlow *et al*., 2008[44]; Matovu *et al*., 2009[45], and Matovu *et al*., 2010[46]).
- Increasing value added exports is one of the pillars of the National Development Plan. On the other hand, reducing imports will improve the country's terms of trade and reduce the trade deficit (See Chapter 2, section 2.5).

***EXRCLOS1:* Fixed foreign savings, flexible exchange rates**

- Foreign savings is fixed at its base level.
- The exchange rate is allowed to vary to clear any deficit or surplus on the current account
- The activity level of the exchange rate is set at the base level.

FSAV.FX = FSAV0;

EXR.LO = -INF;

EXR.UP = +INF;

EXR.L = EXR0;

);

***EXRCLOS2*. Flexible Foreign Savings, Fixed Exchange Rate**

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[43] Thurlow, J., S. Benin, X, Diao, A. Kebba, N. Ofwono (2008). Agricultural Growth and Investment Options for Poverty Reduction in Uganda. IFPRI Discussion Paper No. 00790. Washington, D.C.

[44] Dorosh, P. and J. Thurlow (2009). Agglomeration, Migration and Regional Growth. A CGE Analysis for Uganda. IFPRI Discussion Paper No. 00848. Washington, D.C.

[45] Matovu, M., Rudaherenwa, N. and Kabajulizi, J. (2009). Uganda's Welfare Implications of Policy Reforms under Various Trade Initiatives. Economic Policy Research Centre, Makerere University, Kampala, Uganda

[46] Matovu, M., E. Twimukye, S. Levine, and P. Birungi (2010). Sectoral and Welfare Effects of the Global Economic Crisis on Uganda: A Recursive Dynamic CGE Analysis. Economic Policy Research Centre, Makerere University, Kampala, Uganda.

- A flexible foreign savings is allowed to clear the current account.
- Under this closure, Uganda is able to increase its foreign debt i.e. able to increase the level of imports.
- Like any other developing economy, Uganda continues to import capital and other goods that are essential to her development needs e.g. Heavy machinery to support the industrial sector, petroleum products, and other manufactured goods.
- Unless imports are financed by earnings from exports, this could eventually lead to unfavourable balance of trade if the value of imports exceeds that of exports.
- If imports are financed by public borrowing, the burden of debt is incurred by the future generations.

***EXRCLOS2*: Exchange rate is fixed. *FSAV* is flexible**

- The exchange rate is fixed to its base value.
- Foreign savings is allowed to vary to clear the current account.
- The activity level of foreign savings, *FSAV* is set at its base value.

EXR.FX = EXR0;

FSAV.L = FSAV0;

FSAV.LO = -INF;

FSAV.UP = +INF;

) ;

Savings-Investment Closure Rule (SICLOS)

- Two closures are adopted. Investment is exogenous; Savings is endogenous (Investment driven Savings) and Savings is exogenous, Investment is endogenous (Savings driven investment).

***SICLOS1*: Investment Driven Savings OR Savings is investment driven**

- Under this closure, the total value of savings is determined by the total value of investment.
- In the model, the marginal propensity to save is endogenous, and to finance investment, we choose those institutions whose savings must change via the household savings dummy ($hsdum_i$) which assumes a value of 1 when saving is endogenous and zero when saving is exogenous.
- On the other hand, the household savings adjustment variable, *HSADJ* is zero when saving is endogenous and 1 when savings is exogenous. Possible adjustments in the savings dummy for households are presented in the main GAMS code Appendix B1.

- Matovu *et al.*, (2009)[47] adopts this closure in investigating the effects of Aid allocation on growth and poverty in Uganda.
- Together with the assumption of flexible exchange rates, the saving is investment driven closure enables the CGE model for Uganda to capture the effects of growth on the level of public investment and the crowding out effects from changes in government revenues (Thurlow *et al.*, 2008).

SICLOS1: Investment driven savings

- The household saving dummy takes a value of one for all selected institutions, and the household adjustment variable, *HSADJ* is flexible, allowing savings of selected institutions to adjust to finance investment.
- The activity value of the household saving adjustment variable, *HSADJ* is set to its base value.
- Investment is fixed through the investment adjustment variable to its base value.

```
*GAMS CODE
IADJ.FX = IADJ0;
HSADJ.UP= +INF;
HSADJ.LO = -INF;
HSADJ.L = HSADJ0;
) ;
```

SICLOS2: Saving-Driven Investment or Investment is Savings driven

- The total value of investment spending is determined by the value of savings.
- Investment adjustment variable, *IADJ* is flexible, allowing investment to adjust to finance savings
- The household savings adjustment variable, *HSADJ* is fixed at its base value.
- The activity value of the investment adjustment variable, *IADJ* is set at its base level.

```
*GAMS CODE
HSADJ.FX = HSADJ0;
IADJ.UP= +INF;
IADJ.LO = -INF;
IADJ.L = IADJ0;
) ;
```

---

[47] Matovu, J.M., W. Nabiddo, E. Twimukye (2009). Aid allocation effects on Growth and Poverty in Uganda, A CGE Framework. Economic Policy Research Centre, Makerere University, Kampala, Uganda

Factor Market Closures

- There are two factors of production: capital and labour. Labour is further classified as low skilled and high skilled, male or female, urban or rural.

Capital Markets

- Capital is used in all activities and is fully employed. It can either be mobile or activity specific.
- Like in many developing countries, the full employment closure (neo-classical) is adopted due to the shortage of capital/skills in Uganda.
- In addition, Capital is activity specific because in Uganda, capital used in the Agriculture and service sector is not the same as capital used in the manufacturing sector e.g. simple agriculture tools (hoes and spades vs. generators).
- On the other hand, capital activity specific and mobile but unemployed.

CAPCLOS1: Capital is mobile and fully employed in all activities

- The wage distortion term for Capital, *WFDIST (‘K’, A)* in all activities is fixed.
- A unique capital payment, *WF(‘K’)* adjusts to clear the Capital market.
- The activity level of Capital payment, *WF(‘K’)* is set at the base level.
- The quantity demanded of Capital by all activities, *QF (‘K’, A)* is flexible.
- The current level of Capital demanded by all activities is set at the initial/base level.
- The quantity of unemployed Capital *QFU (‘K’)* is set at the base level of zero (no unemployment).

*GAMS CODE:

```
WFDIST.FX (‘K’, A) = WFDIST0 (‘K’, A);
WF.LO (‘K’) = -INF;
WF.UP (‘K’) = +INF;
WF.L (‘K’) = WF0 (‘K’);
QF.LO (‘K’, A) = -INF;
QF.UP (‘K’, A) = +INF;
QF.L (‘K’, A) = QF0 (‘K’, A);
QFU.FX (‘K’) = QFU0 (‘K’);
);
```

CAPCLOS2: Capital is activity specific and fully employed

- The payment distortion factor for activity specific capital, *WFDIST (‘K’, A)* adjusts to clear the capital market.

- The current value of the payment distortion for activity specific capital, *WFDIST ('K', A) i*s fixed at the base level.
- The payment for activity specific capital, *WF('K')* is fixed at the base level.
- The quantity demanded of capital for each specific activity, *QF('K', A)* is fixed at the base level
- The activity level of unemployed activity specific capital, Q*FU('K')* is set at the base level (zero).
- *GAMS CODE

WFDIST.LO ('K', A) = -INF;

WFDIST.UP ('K', A) = +INF;

WFDIST.L ('K', A) = WFDIST0 ('K', A);

WF.FX ('K') = WF0 ('K');

QF.FX ('K', A) = QF0 ('K', A);

QFU.FX ('K') = QFU0 ('K');

);

CAPCLOS3: Capital is mobile and unemployed in all activities

- The payment distortion factor for Capital, *WFDIST ('K', A)* in all activities is fixed.
- The current level of the payment distortion term for Capital*, WFDIST ('K', A)* in all activities is set at the base level.
- The payment for capital, *WF ('K')* is fixed at the base level.
- The quantity demanded of Capital by all activities, *QF('K', A)* is allowed to vary.
- The current level of Capital demanded by all activities, *QF('K', A)* is set at the initial/base level.
- The level of unemployed Capital, QFU('K') adjusts to clear the labour market
- The current level of unemployment Capital, *QFU('K')* is set at the base level.

*GAMS CODE

WFDIST.FX ('K', A) = WFDIST0 ('K', A);

WF.FX ('K') = WF0 ('K');

QF.LO ('K', A) = -INF;

QF.UP ('K', A) = +INF;

QF.L ('K', A) = QF0 ('K', A);

QFU.LO ('K') = -INF;

QFU.UP ('K') = +INF;

QFU.L (‘K’) = QFU0 (‘K’);

);

CAPCLOS4: Capital is activity specific but unemployed

•The payment distortion factor for activity specific Capital, *WFDIST (‘K’, A)* is fixed.

•The payment for activity specific capital, *WF(‘K’)* is fixed at the base level.

•The quantity demanded of activity specific capital, *QF(‘K’, A)* is flexible.

•The current level of activity specific capital, *QF(‘K’, A)* is set at initial/base level.

•The activity level of unemployed activity specific Capital, *QFU(‘K’)* is set at the base level.

*GAMS CODE

WFDIST.FX(‘K’, A) = WFDIST0(‘K’, A);

WF.FX (‘K’) = WF0 (‘K’);

QF.LO (‘K’, A) = -INF;

QF.UP (‘K’, A) = +INF;

QF.L (‘K’, A) = QF0 (‘K’, A);

QFU.FX (‘K’) = QFU0 (‘K’);

) ;

***Labour Markets**

Labour is used in all activities. It is fully employed but can either be mobile or activity specific. In the CGE model for Uganda, the neoclassical full employment closure is assumed for High Skilled labour due to the shortage of skills and the Keynesian unemployment closure is assumed for Unskilled, Semi-skilled and Low Skilled labour due to notable labour surplus (Unemployment) in Uganda.

LABCLOS1: Labour is mobile and fully employed in all activities

- The wage distortion term for labour, *WFDIST (‘LAB’, A)* in all activities is fixed.
- A unique wage, *WF(‘LAB’)* adjusts to clear the labour market.
- The activity level of the wage, *WF(‘LAB’)* is set at the base level.
- The quantity demanded of labour by all activities, *QF(‘LAB’, A)* is allowed to vary.
- The current level of labour demanded by all activities, *QF(‘LAB’, A)* is set at the initial/base level.
- The quantity of unemployed labour, *QFU (‘LAB’)* is fixed i.e. zero (no unemployment)

*GAMS CODE

WFDIST.FX (‘LAB’, A) = WFDIST0 (‘LAB’, A);

WF.LO (‘LAB’) = -INF;

WF.UP (‘LAB’) = +INF;

WF.L (‘LAB’) = WF0 (‘LAB’);

QF.LO (‘LAB’, A) = -INF;

QF.UP (‘LAB’, A) = +INF;

QF.L (‘LAB’, A) = QF0 (‘LAB’, A);

QFU.FX (‘LAB’) = QFU0 (‘LAB’);

);

LABCLOS2: Labour is activity specific and fully employed

- Policy implication: Shortage of skills in most developing countries especially for high skilled labour (See Dorosh *et al*., 2002).
- The wage distortion activity specific labour, *WFDIST(‘LAB’, A)* adjusts to clear the labour market.
- The wage distortion for activity specific labour, *WFDIST (‘LAB’, A)* is fixed at the base level.
- The wage for activity specific labour, *WF(‘LAB’)* is fixed at the base level.
- The quantity demanded of activity specific labour, *QF(‘LAB’, A)* is fixed at the base level.
- Quantity of unemployed activity specific labour adjusts
- The activity level of unemployed activity specific labour is set at the base level and is equal to zero.

*GAMS CODE

WFDIST.LO (‘LAB’, A) = -INF;

WFDIST.UP (‘LAB’, A) = +INF;

WFDIST.L (‘LAB’, A) = WFDIST0 (LAB, A);

WF.FX (‘LAB’) = WF0 (‘LAB’);

QF.FX (‘LAB’, A) = QF0 (‘LAB’, A);

QFU.FX (‘LAB’) = QFU0 (‘LAB’);

);

LABCLOS3: Labour is unemployed in all activities

This closure rule has policy implications for Uganda. This is because Uganda, like a most developing countries, has surplus labour especially for unskilled, semi-skilled and low skilled labour means that the full employment closure may be unrealistic (Nganou, 2005; Dorosh *et al*., 2002).

- The level of unemployed labour adjusts, *QFU('LAB')* to clear the labour market.
- The wage distortion factor for all labour in all activities, *WFDIST ('LAB', A)* is fixed.
- The current level of the wage distortion for all labour, *WFDIST ('LAB', A)* is set at the base level.
- The wage for all types of labour, *WF('LAB')* is fixed at the base level.
- The quantity demanded for all types of labour by all activities, *QF('LAB, A)* is flexible
- The activity level of labour demanded by all activities, *QF('LAB, A)* is set at the initial/base level.
- The activity level of unemployment of all labour categories, *QFU('LAB')* is fixed. level.

```
*GAMS CODE
WFDIST.FX ('LAB', A) = WFDIST0 ('LAB', A);
WF.FX ('LAB') = WF0 ('LAB');
QF.LO ('LAB', A) = -INF;
QF.UP ('LAB', A) = +INF;
QF.L ('LAB', A) = QF0 ('LAB', A);
QFU.LO ('LAB') = -INF;
QFU.UP ('LAB') = +INF;
QFU.L ('LAB') = QFU0 ('LAB');
  );
```

LABCLOS4: Labour is activity specific and unemployed

- The payment distortion factor for activity specific labour, *WFDIST ('LAB', A)* is fixed.
- The payment for activity specific labour, *WF('LAB')* is fixed at the base level.
- The quantity demanded of activity specific labour, *QF('LAB', A)* is flexible.
- The current level of activity specific labour, *QF('LAB', A)* is set at initial/base level.
- The activity level of unemployed activity specific labour, *QFU('LAB')* is set at the base level.

```
*GAMS CODE
WFDIST.FX('LAB', A) = WFDIST0 ('LAB', A);
WF.FX ('LAB') = WF0 ('LAB');
```

QF.LO ('LAB', A) = -INF;

QF.UP ('LAB', A) = +INF;

QF.L ('LAB', A) = QF0 ('LAB', A);

QFU.FX ('LAB') = QFU0 ('LAB');

) ;

Combining Factor Market Closures for Simulations with CGE_UGA1

- In all our simulations, we report results based on a combination of closures that have been widely used in other studies.
- Our simulation results are based on a combination of three closures commonly used in most CGE models in developing countries (See Dorosh *et al*., 2002, Thurlow, *et al*., 2009; Nganou, 2005).
- We assume capital is activity specific and fully employed, high skilled labour is fully employed and mobile, low skilled labour is unemployed and mobile in all simulations. The policy implications of this type of closure are discussed above.

***Capital is activity specific and fully employed in all activities; high skilled labour is mobile and fully employed in all activities; low skilled labour is unemployed and mobile.**

CAPCLOS2: Capital is activity specific and fully employed in all activities

- The payment distortion factor for activity specific capital, *WFDIST ('K', A)* adjusts to clear the capital market.
- The current value of the payment distortion for activity specific capital, *WFDIST ('K', A) i*s fixed at the base level.
- The payment for activity specific capital, *WF('K')* is fixed at the base level.
- The quantity demanded of capital for each specific activity, *QF('K', A)* is fixed at the base level
- The activity level of unemployed activity specific capital, Q*FU('K')* is set at the base level (zero).

GAMS CODE:

WFDIST.LO ('K', A) = -INF;

WFDIST.UP ('K', A) = +INF;

WFDIST.L ('K', A) = WFDIST0 ('K', A);

WF.FX ('K') = WF0 ('K');

QF.FX ('K', A) = QF0 ('K', A);

QFU.FX ('K') = QFU0 ('K');

***LABCLOS1: High Skilled labour is mobile and fully employed in all Activities**

- The wage distortion term for each category of High Skilled labour, *WFDIST ('HS_LAB', A)* in all activities is fixed.
- A unique wage for each type of skilled labour, *WF('HS_LAB')* adjusts to clear the market for High Skilled labour
- The activity level of the wage, *WF('HS_LAB')* for each type of High skilled labour is set at the base level.
- The quantity demanded of each type of High Skilled labour, *QF ('HS_LAB', A)* by all activities is allowed to vary.
- The current level of High Skilled labour demanded by all activities, Q*F('HS_LAB', A)* is set at the initial/base level.
- The quantity of unemployed for all categories of High Skilled labour, *QFU('HS_LAB')* is set at the base level.

*GAMS CODE:

```
WFDIST.FX ('HS_RM', A) = WFDIST0 ('HS_RM', A);
WFDIST.FX ('HS_RF', A)  = WFDIST0 ('HS_RF', A);
WFDIST.FX ('HS_UM', A) = WFDIST0 ('HS_UM', A);
WFDIST.FX ('HS_UF', A)  = WFDIST0 ('HS_UF', A);
WF.LO('HS_RM') = -INF;
WF.UP ('HS_RM') = +INF;
WF.LO ('HS_RF')  = -INF;
WF.UP ('HS_RF')  = +INF;
WF.LO ('HS_UM')  = -INF;
WF.UP ('HS_UM') = +INF
WF.LO ('HS_UF') = -INF;
WF.UP ('HS_UF') = +INF;
WF.L ('HS_RM') = WF0 ('HS_RM');
WF.L ('HS_RF') = WF0 ('HS_RF');
WF.L ('HS_UM') = WF0 ('HS_UM');
WF.L ('HS_UF') = WF0 ('HS_UF');
QF.LO ('HS_RM', A) = -INF;
QF.UP ('HS_RM', A) = +INF;
QF.LO ('HS_RF', A) = -INF;
QF.UP ('HS_RF', A) = +INF;
QF.LO ('HS_UM', A) = -INF;
QF.UP ('HS_UM', A) = +INF;
```

QF.LO (‘HS_UF’, A) = -INF;

QF.UP (‘HS_UF’, A) = +INF;

QF.L (‘HS_RM’, A) = QF0 (‘HS_RM’, A);

QF.L (‘HS_RF’, A) = QF0 (‘HS_RF’, A);

QF.L (‘HS_UM’, A) = QF0 (‘HS_UM’, A);

QF.L (‘HS_UF’, A) = QF0 (‘HS_UF’, A);

QFU.FX (‘HS_RM’) = QFU0 (‘HS_RM’);

QFU.FX (‘HS_RF’) = QFU0 (‘HS_RF’);

QFU.FX (‘HS_UM’) = QFU0 (‘HS_UM’);

QFU.FX (‘HS_UF’) = QFU0 (‘HS_UF’);

LABCLOS3: Low Skilled labour is mobile and unemployed in all activities

- The quantity of unemployed Low Skilled labour, *QFU(‘LS_LAB’)* adjusts to clear the labour market
- The wage distortion factor for each type of Low Skilled labour in all activities, *WFDIST(‘LS_LAB’, A)* is fixed.
- The current level of the wage distortion for Low Skilled labour in all activities, *WFDIST (LS_LAB, A)* is fixed at the base level.
- The wage for each type of Low Skilled labour, *WF(‘LS_LAB’)* is fixed at the base level.
- The quantity demanded of each type of Low Skilled labour by all activities, *QF(‘LS_LAB’, A)* is flexible.
- The current level of each category of Low Skilled labour demanded by all activities, *QF(‘LS_LAB’, A)* is set at the initial/base level.
- The current level of each type of unemployed Low Skilled labour, *QFU(‘LS_LAB’)* is set at the base level.

WFDIST.FX (‘LS_RM’, A) = WFDIST0 (‘LS_RM’, A);

WFDIST.FX (‘LS_RF’, A) = WFDIST0 (‘LS_RF’, A);

WFDIST.FX (‘LS_UM’, A) = WFDIST (‘LS_UM’, A);

WFDIST.FX (‘LS_UF’, A) = WFDIST0 (‘LS_UF’, A);

WF.FX (‘LS_RM’) = WF0 (‘LS_RM’);

WF.FX (‘LS_RF’) = WF0 (‘LS_RF’);

WF.FX (‘LS_UM’) = WF0 (‘LS_UM’);

WF.FX (‘LS_UF’) = WF0 (‘LS_UF’);

QF.LO (‘LS_RM’, A) = -INF;

QF.UP (‘LS_RM’, A) = +INF;

QF.LO (‘LS_RF’, A) = -INF;

QF.UP (‘LS_RF’, A) = +INF;

QF.LO (‘LS_UM’, A) = -INF;

QF.UP (‘LS_UM’, A) = +INF;

QF.LO (‘LS_UF’, A) = -INF;

QF.UP (‘LS_UF, A) = +INF;

QF.L (‘LS_RM’, A) = QF0 (‘LS_RM’, A);

QF.L (‘LS_RF’, A) = QF0 (‘LS_RF’, A);

QF.L (‘LS_UM’, A) = QF0 (‘LS_UM’, A);

QF.L (‘LS_UF’, A) = QF0 (‘LS_UF’, A);

QFU.LO (‘LS_RM’) = -INF;

QFU.UP (‘LS_RM’) = +INF;

QFU.LO (‘LS_RF’) = -INF;

QFU.UP (‘LS_RF’) = +INF;

QFU.LO (‘LS_UM’) = -INF;

QFU.UP (‘LS_UM’) = +INF;

QFU.LO (‘LS_UF’) = -INF;

QFU.UP (‘LS_UF’) = +INF;

QFU.L (‘LS_RM’) = QFU0 (‘LS_RM’);

QFU.L (‘LS_RF’) = QFU0 (‘LS_RF’);

QFU.L (‘LS_UM’) = QFU0 (‘LS_UM’);

QFU.L (‘LS_UF’) = QFU0 (‘LS_UF’);

) ;

Appendix C

C1 The 2002 Disaggregated SAM (Uganda Million Shillings)-Activity Block

	AGRI_A	MIN_A	PROC_A	MAN_A	ELEC_A	CONS_A	TRS_A	TRAN_A	HEAL_A	OTH_A
AGRI_A	0	0	0	0	0	0	0	0	0	0
MIN_A	0	0	0	0	0	0	0	0	0	0
PROC_A	0	0	0	0	0	0	0	0	0	0
MAN_A	0	0	0	0	0	0	0	0	0	0
ELEC_A	0	0	0	0	0	0	0	0	0	0
CONS_A	0	0	0	0	0	0	0	0	0	0
TRS_A	0	0	0	0	0	0	0	0	0	0
TRAN_A	0	0	0	0	0	0	0	0	0	0
HEAL_A	0	0	0	0	0	0	0	0	0	0
OTH_A	0	0	0	0	0	0	0	0	0	0
AGRI_C	508529	0	670648	102695	0	0	0	0	110	29449
MIN_C	14	35	1218	14179	0	33546	0	1	0	16
PROC_C	32023	0	372269	39694	0	579	28183	4267	1735	35905
MAN_C	138844	5617	168855	592773	25408	530567	124498	97650	196150	308789
ELEC_C	6535	778	18567	16970	7899	4122	23424	6751	24713	59181
CONS_C	1375	82	8567	6442	5	50015	5392	1930	13721	129963
TRS_C	79462	1309	193505	103820	5025	60413	30909	31151	60841	99381
TRAN_C	53034	110	53564	37308	1018	63852	149603	5853	21836	133393
HEAL_C	39142	87	14224	10522	756	8032	2770	1188	125203	130656
OTH_C	27493	3719	145314	109783	12277	47805	263382	35037	154533	1006746
LS_RM	434117	4102	18712	11083	240	17340	19663	5610	22979	46987
LS_RF	67483	480	1853	3	0	0	0	1420	5241	22769
LS_UM	23916	1896	15911	26803	1631	20514	30679	9382	1943	59981
LS_UF	4608	203	30229	2838	0	0	8010	16209	3583	9484
HS_RM	48127	0	12585	30576	16245	67663	10045	2752	401988	128488
HS_RF	16939	0	4378	0	0	0	2998	0	110819	109100
HS_UM	21716	69	29794	37464	21091	29170	99414	15193	123215	675768
HS_UF	324	0	6383	1315	28918	980	31158	7974	151090	198826
K	2075439	27264	195856	2921	321705	1030563	984467	276597	186966	1570210
E	0	0	0	0	0	0	0	0	0	0
CR_H	0	0	0	0	0	0	0	0	0	0
CU_H	0	0	0	0	0	0	0	0	0	0
ER_H	0	0	0	0	0	0	0	0	0	0
EU_H	0	0	0	0	0	0	0	0	0	0
NR_H	0	0	0	0	0	0	0	0	0	0
NU_H	0	0	0	0	0	0	0	0	0	0
WR_H	0	0	0	0	0	0	0	0	0	0
WU_H	0	0	0	0	0	0	0	0	0	0
G	0	0	0	0	0	0	0	0	0	0
R	0	0	0	0	0	0	0	0	0	0
AC_TAX	1119	2149	15202	293364	0	6713	0	0	64	34028
IM_TAX	0	0	0	0	0	0	0	0	0	0
VA_TAX	0	0	0	0	0	0	0	0	0	0
S_I	20506	1303	67040	60087	48730	42051	45136	24297	42931	168689
	3600745	49204	2044673	1500643	490949	2013926	1859732	543263	1649661	4957810

Source: Compiled by Author. Data is from Alcorn *et al*. (2006). Figures in Million Uganda Shillings. Sets defined as in Appendix A1.

C2 The 2002 Disaggregated SAM for Uganda continued- Commodities to Factors Block

	AGRI_C	MIN_C	PROC_C	MAN_C	ELEC_C	CONS_C	TRS_C	TRAN_C	HEAL_C	OTH_C	LS_RM	LS_RF	LS_UM	LS_UF	HS_RM	HS_RF	HS_UM	HS_UF	K
AGRI_A	3270120	0	329935	0	0	8	0	32	0	650	0	0	0	0	0	0	0	0	0
MIN_A	0	48580	0	453	0	54	0	0	0	116	0	0	0	0	0	0	0	0	0
PROC_A	14066	0	1967503	51676	0	6627	0	0	0	4801	0	0	0	0	0	0	0	0	0
MAN_A	6078	2559	43134	1427080	1162	17685	37	236	0	2672	0	0	0	0	0	0	0	0	0
ELEC_A	0	0	0	0	484698	0	0	0	0	6251	0	0	0	0	0	0	0	0	0
CONS_A	0	0	0	3644	0	2009473	0	0	0	809	0	0	0	0	0	0	0	0	0
TRS_A	3402	0	0	17860	0	0	1813667	4652	0	20151	0	0	0	0	0	0	0	0	0
TRAN_A	0	0	0	0	0	0	4570	535954	0	2739	0	0	0	0	0	0	0	0	0
HEAL_A	2	0	0	36929	0	0	0	0	1569639	43091	0	0	0	0	0	0	0	0	0
OTH_A	0	0	6461	17150	0	11682	166409	114550	283770	4357788	0	0	0	0	0	0	0	0	0
AGRI_C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MIN_C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
PROC_C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
MAN_C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
ELEC_C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
CONS_C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TRS_C	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0
TRAN_C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HEAL_C	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0
OTH_C	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LS_RM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LS_RF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LS_UM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
LS_UF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HS_RM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HS_RF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HS_UM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
HS_UF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
K	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
E	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2143282
CR_H	0	0	0	0	0	0	0	0	0	0	176823	30070	0	0	210810	67662	0	0	790220
CU_H	0	0	0	0	0	0	0	0	0	0	209	0	124648	53101	0	0	679046	320325	1651293
ER_H	0	0	0	0	0	0	0	0	0	0	113747	23238	0	0	119751	47256	0	0	650714
EU_H	0	0	0	0	0	0	0	0	0	0	0	0	16468	4622	0	0	105338	40757	116714
NR_H	0	0	0	0	0	0	0	0	0	0	79314	29076	0	0	168867	26581	778	0	159392
NU_H	0	0	0	0	0	0	0	0	0	0	1486	0	13198	4816	0	0	89898	16056	34824
WR_H	0	0	0	0	0	0	0	0	0	0	199938	15089	0	0	193667	96812	274	0	820156
WU_H	0	0	0	0	0	0	0	0	0	0	160	0	33222	11319	0	0	154247	38423	305394
G	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
R	95049	27469	218275	1995907	0	0	0	388694	0	224686	9158	1775	5120	1305	25376	5922	23315	11406	0
AC_TAX	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
IM_TAX	1103	2149	16945	365239	0	0	0	0	0	44	0	0	0	0	0	0	0	0	0
VA_TAX	66881	2052	130768	106146	21511	9670	206	19664	48646	58034	0	0	0	0	0	0	0	0	0
S_I	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	3456701	82809	2713021	4022084	507371	2055199	1984889	1063782	1902055	4721832	580834	99248	192656	75164	718471	244233	1052894	426968	6671988

Source: Compiled by Author. Data is from Alcorn *et al*. (2006). Figures in Million Uganda Shillings. Sets defined as in Appendix A1.

C3 The 2002 Disaggregated SAM for Uganda: Institutions, Tax and Capital Account Block

	E	CR_H	CU_H	ER_H	EU_H	NR_H	NU_H	WR_H	WU_H	G	R	AC_TAX	IM_TAX	VA_TAX	S_I	TOTAL
AGRI_A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3600745
MIN_A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	49203
PROC_A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2044673
MAN_A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1500643
ELEC_A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	490949
CONS_A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2013926
TRS_A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1859732
TRAN_A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	543263
HEAL_A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1649661
OTH_A	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4957810
AGRI_C	0	519077	161554	378635	28667	216423	17462	443875	40537	0	293230	0	0	0	45810	3456701
MIN_C	0	4581	1651	4669	436	4067	372	6894	665	0	10286	0	0	0	179	82809
PROC_C	0	343935	319583	339352	71497	171362	32220	291976	56518	0	447599	0	0	0	124327	2713021
MAN_C	0	275133	286921	193873	45762	109380	22634	212182	48576	0	159465	0	0	0	479009	4022085
ELEC_C	0	83572	53304	61768	9750	30921	4262	56911	10799	0	27144	0	0	0	0	507371
CONS_C	0	22016	79118	9590	1172	910	1196	25666	4096	0	0	0	0	0	1693944	2055199
TRS_C	0	278460	187563	223340	35666	122140	17712	232697	35649	0	118719	0	0	0	67126	1984889
TRAN_C	0	109068	107775	72476	20277	30134	6896	81924	16290	1590	88428	0	0	0	9352	1063782
HEAL_C	0	168257	217490	116537	35429	39590	10594	130616	31221	819400	0	0	0	0	340	1902055
OTH_C	0	366477	569765	190113	58163	72422	27906	198076	75446	987831	369419	0	0	0	125	4721832
LS_RM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	580835
LS_RF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	99249
LS_UM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	192656
LS_UF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	75164
HS_RM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	718471
HS_RF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	244233
HS_UM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1052894
HS_UF	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	426968
K	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6671988
E	190852	1403	5991	602	917	245	178	2051	2643	98726	125924	0	0	0	0	2572813
CR_H	276916	0	557351	0	0	0	0	0	0	11918	136769	0	0	0	0	2258540
CU_H	582643	0	0	0	0	0	0	0	0	29682	128308	0	0	0	0	3569255
ER_H	219925	0	124118	0	78138	0	0	0	83233	11899	159071	0	0	0	0	1631092
EU_H	68363	0	42041	0	0	0	0	0	28192	3584	62815	0	0	0	0	488895
NR_H	104629	0	54557	0	0	0	78932	0	36586	4943	67814	0	0	0	0	811467
NU_H	37576	0	18919	0	0	0	1178	0	12687	1010	33007	0	0	0	0	264655
WR_H	270393	0	0	0	0	0	0	37985	65769	5829	69227	0	0	0	0	1775138
WU_H	107062	0	0	0	0	0	0	0	0	1499	11942	0	0	0	0	663268
G	130921	18078	83844	12100	4505	8279	3820	23707	3918	0	1080258	352639	385480	463578	0	2571127
R	200545	0	406597	0	68826	0	24792	0	78444	55247	0	0	0	0	-478483	3389425
AC_TAX	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	352639
IM_TAX	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	385480
VA_TAX	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	463578
S_I	382989	68483	291113	28037	29690	5594	14502	30580	32000	537970	0	0	0	0	0	1941729
Total	2572814	2258540	3569255	1631092	488895	811467	264656	1775139	663269	2571128	3389425	352639	385480	463578	1941729	

Source: Compiled by Author. Data is from Alcorn *et al*. (2006). Figures in Million Uganda Shillings. Sets defined as in Appendix A1.

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